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BIOMEDICAL AND BEHAVIORAL SCIENCES

No. 1

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CLONING CHLOROPLAST DNA IN E. COLI UDC 575.11:576.851.48

Moscow GENETIKA in Russian Vol 15 No 11 Nov 79 pp 1918-1924 manuscript received 3 Jan 79

ANDRIANOV, V. M., AMERKHANOV, M. B. and VINETSKIY, Yu. P.: (CLONING CHLOROPLAST DNA in ESCHERICHIA COLI. COMMUNICATION 2. SOME PROPERTIES OF RECOMBINANT PLASMIDS WHICH CARRY EcoRI-FRAGMENTS OF PISUM SAVTIVUM CHLOROPLAST DNA AND THE CLONING OF DNA SEQUENCES WITH rRNA GENES) Institute of General Genetics, USSR Academy of Sciences, Moscow

[Abstract] Andrianov, et al., have already (1976, 1977, 1978) described a method of selection of colicine-defective recombinant plasmids, using mitomycin C. With this method, clones of bacteria had been obtained with plasmids of chloroplasts of Pisum sativum into which various EcoRI-fragments of the chloroplast DNA were included. In the present article, the properties of these fragments, after "amplification" in bacterial cells, are described. The cloroplast DNA EcoRI fragments cloned in E. coli have a variable nucleotide content with substantially-enriched AT-pairs in some of the nucleotides; fragments with a predominant content of GC pairs were not cloned; the nucleotide makeup of the chloroplast DNA was seen, by ultracentrifugation analysis, to be heterogeneous with respect to length. The recombinant plasmid DNAs were alkali stable, indicating absence of ribonucleotides. Figures 4; references 14: 4 Russian, 10 Western (one of which is by Andrianov, et al.).
[107-8586]

USSR UDC 547.963.32

SYNTHESIS OF THE LEUCINE-ENCEPHALIN GENE AND ITS CLONING AND EXPRESSION IN ESCHERICHIA COLI

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 248 No 6, 1979 pp 1486-1491

OVCHINNIKOV, YU.A., academician, DOLGANOV, G. M., YEFIMOV, V.A., MONASTYRSKAYA, G.S., SVERDLOV, YE.D., KHODKOVA, YE.M., CHAKHMAKHCHEVA, O.G., CHESTUKHIN, A.V., and SHEMYAKIN, M.F., Institute of Bioorganic Chemistry imeni M.M. Shemyakin, USSR Academy of Sciences, Moscow

[Abstract] Standard techniques of molecular biology and genetic engineering were employed for the synthesis of a polydeoxyribonucleotide sequence corresponding to the leucine-encephalin gene, and its subsequent incubation with vector plasmid pBR 322 DNA (following hydrolysis with Eco RI and Bam HI endonucleases) and phage Cha 4A DNA (treated with Eco RI) in the presence

of T4 DNA ligase. The resultant DNA product was then employed in the transformation of E. coli HB 101, with the transformed cells being tested for leucine-encephalic production by radioimmunoassay. The results showed that each bacteria containing the reconstructed plasmid produced ca. 5 x 10^4 molecules of encephalin. Figures 2; references 15: 2 Russian, 13 Western.
[71-12172]

USSR UDC 575.114.3

ALTERATIONS IN RECOMBINANT PLASMIDS WHICH AFFECT THEIR EXPRESSION IN ESCHERICHIA COLI K-12

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 248 No 5, 1979 pp 1245-1249 manuscript received 14 Apr 79

VEL'KOV, V.V., FODOR, I.I. and BAYEV, A.A., academician, Institute of Biochemistry and Physiology of Microorganisms, USSR Academy of Sciences, Pushchino, Moscow Oblast

[Abstract] Studies were conducted on the complementation of thr^- point mutation in E. coli by means of recombinant plasmids, using phenotypic characteristics of E. coli to follow changes in the plasmid. A mixture of DNA molecules from strain Streptomyces streptomycini 232 and vector plasmid pCV20 (both DNA preparations pretreated with restrictase Bam HI) were ligated with T4 DNA ligase and the resultant DNA was used for the transformation of E. coli JC 7623 recBC sbc B $arg^-his^-thr^-pro^-leu^-$. Subsequently, a plasmid designated as pSt thr1 was isolated from an E. coli clone with the phenotype $thr^+arg^-his^-pro^-leu^-Ap^rTc^s$ (Ap^r = ampicillin resistant, Tc^s = tetracycline susceptible); its DNA was not restricted by endonucleases Bam HI, Hind III, or Sal I, but only by Eco RI and Sma I, while each of these enzymes restricted pCV20 DNA. pSt thr 1 DNA was used for the transformation of the E. coli JC 7623 strain and E. coli AB 2463; five transformed bacterial clones were isolated with yielded five distinct plasmids which differed from pCV20 in terms of the molecular weight of their DNA molecules and susceptibilities to restrictive endonucleases. These findings were interpreted to support the contention that the initial structure of the recombinant plasmid underwent significant alterations in both JC 7623 and AB 2463 cells. Figures 2; references 12: 3 Russian, 9 Western.
[79-12172]

USSR UDC: 577.156

IMMOBILIZED PROTEINASES USED TO PURIFY SHEEP POX VIRUS

Moscow BIOKHIMIYA in Russian Vol 44 No 10, 1979 pp 1776-1778 manuscript received 29 Jan 79

SHEDRIN, Ye. L.; PROSTYAKOV, A. P.; TYAGANKOVA, S. I., SKALINSKIY, Ye. I., ZINKEVICH, O.D., TITOVA, Ye. G., and BORISOVICH, Yu. F., All-Union State Scientific Control Institute of Veterinary Products, USSR Ministry of Agriculture, Moscow, and Kazan' State Medical Institute

[Abstract] Papain (Merck Co, FRG) and trypsin (Spofa Firm, Czechoslovakia) were immobilized on biogel P-100 at room temperature by the Western technique (1971). These immobilized enzymes were used to treat sheep pox virus of the Poxviridae family, genus Carpipoxvirus. This procedure purified the viral suspension as a result of hydrolysis of inactive proteins, and can apparently be used to purify other virions and proteins by means of proteolysis of low molecular protein admixtures. Figure 1; references 7: 2 Russian, 5 Western. [76-10,657]

USSR UDC 577.154

PROPERTIES OF IMMOBILIZED SUBUNITS OF TRANSKETOLASE

Moscow BIOKHIMIYA in Russian Vol 44 No 12 Dec 79 pp 2115-2120 manuscript received 8 Feb 79

SOLOV'YEVA, O. N. and KOCHETOV, G. A., Laboratory of Molecular Biology and Bioorganic Chemistry imeni A. N. Belozerskiy, Moscow State University, Moscow

[Abstract] Attempts at separate study of the subunits of enzymes, whose function requires an oligomeric structure, are made difficult because the subunits naturally tend to associate. The molecule of transketolase of baker's yeast consists of two subunits identical with respect to molecular weight. In an earlier report (by the authors, 1978 in which the technique was described) the enzyme had been immobilized by covalent bonding with sepharose per subunit. The attendant loss of activity was restored by addition--at appropriate pH--of free subunits of transketolase. The immobilized subunits were found to be catalytically active, and, in this article their properties are studied. The properties studied included i) optimum pH for catalytic activity in the presence of magnesium or calcium ions, ii) relative affinity for the substrates--a substrate-donor and substrate-acceptor of transketolase--and iii) value of the dissociation constant for thiamine

pyrophosphate (TPP). These values did not differ substantially for the immobilized subunits, the immobilized dimer form of the enzyme or the soluble transketolase. In the presence of calcium ions, the immobilized subunits and, also, the soluble transketolase had two types of binding sites for TPP with clearly different affinities for the coenzyme. Thus, the active centers in the dimer molecule appear to be independent. In the immobilization process, a part of the enzyme molecule is completely inactivated and another part fully retains its activity. Catalytic activity of the free and immobilized transketolase was assayed spectrophotometrically according to rate of reduction of oxidized NAD, using glyceraldehydephosphate dehydrogenase as the auxiliary enzyme. Figures 3; references 24: 3 Russian, 20 Western (3 of which were authored by Kochetov, et al.).
[139-8586]

USSR UDC: 577.158.34

HYBRIDIZATION OF IMMOBILIZED D-GLYCERALDEHYDE-3-PHOSPHATE DEHYDROGENASE

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 248, No 1 1979 pp 238-241
manuscript received 7 Jun 79

NAGRADOVA, N. K., MURONETS, V. I., ASRIYANTS, R. A. and CHEREDNIKOVA, T. V., Moscow State University imeni M. V. Lomonosov, submitted by Academician S. Ye. Severin on 30 May 79

[Abstract] Recovery of immobilized hybrids of D-glyceraldehyde-3-phosphate dehydrogenase is described, and use thereof for the study of intersubunit interactions in the enzyme molecule is discussed. The material consisted of immobilized apoenzyme dimers from yeast or rat skeletal muscle. The techniques used permit analysis of kinetics of hybridization conditions (immobilized dimers of D-glyceraldehyde-3-phosphate dehydrogenase with soluble dimers) and determination of conditions under which the formed oligomer could undergo dissociation. Figures 2; references 14: 2 Russian, 12 Western.
[73-10,657]

USSR UDC 577.15.024.035.156

FIXATION OF A LIGHT SIGNAL BY A DYE SUBSTANCE IN MICROCAPSULES CONTAINING cis-CINNAMOYLCHYMOTRYPSIN

Moscow BIOKHIMIYA in Russian Vol 44 No 12 Dec 79 pp 2227-2233 manuscript received 3 May 79

AYSINA, P. B., ANDRIANOVA, I. P., KAZANSKAYA, N. I. and LUKASHEVA, YE. V., Chemical Faculty of Moscow State University imeni M. V. Lomonosov

[Abstract] The author's laboratory has been developing highly-sensitive enzyme systems which can be used as photographic materials; catalytically inactive derivatives of proteolytic enzymes are activated with exposure to light. The photographic material is said to be qualitatively more sensitive than that described in several US patents (1970,1972) which involve photoinactivation of proteolytic enzymes under direct action of light. The present article reports efforts to control washing out--from a gelatine backing--of the produced image because of diffusion of the enzyme during wet development. Cis-cinnamoyl chymotrypsin, the stable, light-sensitive derivative of alpha-chymotrypsin was immobilized by micro-encapsulation into semi-permeable nylon membranes which were then attached onto the surface of the gelatin backing. The high concentrations of the enzyme, forming under the action of light, are limited by the volume of the capsules and can bring about catalytic conversion of a low-molecular substrate diffusing inside the capsule from the surrounding solution. The low MW substrates used, which penetrate into the capsules, were indoxyl esters of acetic or butyric acid or N-acetyl-L-leucine; there are hydrolyzed to indoxyl, in turn oxidized by oxygen to form indigo which stains the capsules. Diffusion into the photosensitive layer is thus prevented. Figures 2; references 14: 8 Russian, 6 Western (two by Soviet authors).
[139-8586]

USSR UDC 57:536.48.047

PROBLEMS CONNECTED WITH THE THAWING OF BIOLOGICAL MATERIALS

Kiev VISNYK AKADEMIYI NAUK UKRAYINS'KOYI RSR in Ukrainian No 7, Jul 79 pp 76-83

[PUSHKAR, M.S., corresponding member, UkrSSR, LOBINTSEVA, G.S. and POLYAKOVA, A.I., candidates of biological sciences and TIMOSHENKO, YU.P.

[Abstract] This is a review of the literature on cryopreservation of biological materials and their recovery from the anabiotic state. The review covered three sub-topics: cryodestruction of biological systems, occuring

during the thawing process; current methods of thawing; and theoretical considerations of these relationships. The authors concentrated on a range of temperatures in relationship to freezing rates, because they believed that damage to the cells could be avoided by proper selection of optimal freezing-thawing rates. Thawing rates, to be least destructive, should correspond to the freezing rates. The heating process of any substance depends on physical properties of the heated object, its geometrical form, dimensions and its relationship to the surroundings. The real problem faced in this process is the constantly changing temperature gradient between the heat source and the object, which alters the heating rate of the latter during the warm-up process. This can be corrected to some extent by the use of super high frequency current. References 49: 17 Russian, 32 Western.
[82-7813]

USSR

STUDY OF MOLECULAR STRUCTURE AND MECHANISMS OF FUNCTION OF CHOLINORECEPTORS OF LYMNAEA STAGNALIS NEURONS BY IN VIVO CHEMICAL MODIFICATION

Moscow BIOFIZIKA in Russian Vol 24 No 5 Sep/Oct 79 pp 854-859 manuscript received 28 Jan 77 and (after modification) 17 Jul 78

BREZHESTOVSKIY, P. D., VUL'FIUS, YE. A., IL'YIN, V. I. and YURCHENKO, O. P., Institute of Bilogical Physics, USSR Academy of Sciences, Pushchino (Moscow Oblast)

[Abstract] Group-specific reagents were used to modify the structure of neurons of the large and small parietal ganglia of Lymnaea stagnalis L. to study function of their cholinoreceptors. The method involved chemically treating the protein fractions or the tissue whose reactive protein sites formed a covalent bond with the reagents (Baker, 1967; Singer, 1967; Vul'fius, et al., 1975). Reagents used included dithiotreitol--specifically reducing S-S bonds,--and a number of alkylating agents--reacting with SH-groups. When the S-S bond is reduced by the dithiotreitol, the cholinoreceptors are inactivated. The S-S groups can be protected from this inactivation by using cholinoreceptor excitants,--cholinomimetics, e.g., tetramethyl-ammonium, and decamethonium--a procedure which appears to alter the conformation of the active center and its surroundings. The capacity of substances to protect the cholinoreceptors correlated with their capacity to increase the conductivity of the membrane. Figures 5; references 13: 5 Russian, 8 Western (one by Soviet authors).
[60-8586]

USSR

UDC 576.8.097.29:582.288

EFFECTS OF MYCOTOXINS ON VERO CELLS

Kiev MIKROBIOLOGICHESKIY ZHURNAL in Russian, No 5, Sep/Oct 79 pp 526-529

[Article by N. I. Nagrodnaya, Yu. A Barshteyn and Z. A. Kuratskaya: (THE EFFECT OF FUNGAL TOXINS ON THE MITOTIC REGIMEN OF VERO CELLS) Kiev Scientific Research Institute of Epidemiology, Microbiology and Parasitology, Institute of Microbiology and Virology, Ukrainian SSR Academy of Sciences]

[Abstract] Changes in the mitotic regimen of Vero cells resulting from the exposure to mycotoxins were studied. Mycotoxins in doses of 10 ug/ml and higher were found to be lethal to the cells, therefore a 1 ug/ml dose was used in the experiments. Inhibition of cell mitotic activity was achieved with fumigatin, datulin and dendrodochin. Fusarin, fusaric acid, gelvolic acid and stachybotriotoxin showed no significant effect on the mitotic regimen at this dose. The inhibition of mitotic activity could have been connected with some disorder in the mitotic cycle of the cells. Figure 1, references 19: 11 Russian, 8 Western.
[101-7813]

USSR

UDC: 577.158.54

HIGHLY PURIFIED LUCIFERASE FROM LUCIOLA MINGRELICA FIREFLIES AND ITS KINETIC PROPERTIES

Moscow BIOKHIMIYA In Russian Vol 44 No 10, 1979 pp 1899-1905 manuscript received 20 Mar 79

FILIPPOVA, N. YU. and UGAROVA, N. N., Chair of Chemical Enzymology, Chemistry Faculty of Moscow State University imeni M. V. Lomonosov

[Abstract] Luciferin synthesized in the authors' laboratory was used, as well as EDTA, bovine serum albumin, myoglobin, Reanal (Hungary) ovalbumin, Calbiochem (United States) pepsin and ATP as the material to test activity of luciferase from L. mingrelica, used in a purified state for the first time, as well as to determine the kinetic parameters of the luciferase. Ion-exchange chromatography was chosen to purify this luciferase, and divided precipitation with ammonia sulfate followed by purification on DEAE-sephadex were performed to prevent the loss of activity found at the stage of gel filtration through sephadex G-10. Formulas are submitted to describe the kinetics of action of luciferase. The purified luciferase obtained from L. mingrelica differs somewhat from that of Phophinus pyralis fireflies described before, but both present the same substrate specificity and similar biochemical properties. Figures 3; references 16: 5 Russian, 11 Western.
[76-10,657]

USSR UDC: 577.15.612.015.1

IMMOBILIZATION OF ENZYMES ON BLOOD CELLS BY ADSORPTION

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 249, No 1, 1979 pp 235-237 manuscript received 30 May 79

LEVIN, F. B.; SOROKINA, L. V.; and BEREZOV, T. T., People's Friendship University imeni Patrice Lumumba, Moscow, and Moscow Stomatological Medical Institute imeni N. A. Semashko, submitted by Academician A. Ye. Braunshteyn on 10 Apr 79

[Abstract] Determination was made of the possibility of using human and rabbit blood cells to recover immobilized enzymes, which involves the use of carriers, named biocompatible carriers, for use in medicine and biology. Crystalling glucose oxidase (manufactured at the L'vov Plant), peroxidase and arginase (lyophilized enzymes manufactured by Reanal) were used. Human erythrocytes adsorbed these enzymes much less than rabbit blood cells. Thrombocytes have greater adsorptive capacity than erythrocytes. When bound with blood cells, the enzymes are insoluble, many times more heat resistant, forming a rather stable bond with the cell matrix, and they can be considered immobilized. The nature of the enzyme-blood cell bonds has not been identified, but it is suggested that there is both sorption of the enzyme on the outer surface of the cell wall and immobilization due to incorporation of enzyme molecules in the fine pores of cell membranes. Figures 2; references 11: 6 Russian, 5 Western.
[73-10,657]

USSR UDC: 577.158.45:15.062

INVESTIGATION OF KINETICS OF THE ASPARTATE-AMINOTRANSFERASE REACTION CATALYZED BY FREE AND IMMOBILIZED ESCHERICHIA COLI CELLS

Moscow BIOKHIMIYA in Russian Vol 44 No 10, 1979 pp 1787-1795 manuscript received 8 Feb 79

YAKOVLEVA, V. I., MALOFEYEVA, I. V., FAM VAN NGUYEN and BEREZIN, I. V., Chemistry Faculty and Laboratory of Molecular Biology and Bioorganic Chemistry, Moscow State University imeni M. V. Lomonosov

[Abstract] E. coli strain 85 was the material used; cells thereof were immobilized by incorporation in polyacrylamide gel with chemical polymerization of acryl constituents, and the aspartate-aminotransferase reaction was run under standard conditions. Kinetics thereof was assessed on the basis of accumulation of oxalacetic acid using a Beckman DB-GB spectrometer.

Thin-layer chromatography on Fixion plates was used to identify glutamic acid formed. This is the first publication dealing with recovery of fixed cells with aspartate-aminotransferase activity. The following parameters were determined: kinetics of accumulation of oxalacetic acid in reaction catalized by E. coli cells, kinetics of accumulation of the same acid in aspartate-aminotransferase reaction catalyzed by free cells of E. coli, the same parameter with the use of E. coli cells pretreated with toluene at room temperature, kinetics of oxalacetic acid accumulation during same reaction catalyzed by free, dissociated and fixed E. coli cells, effective rates of the aspartate-aminotransferase reaction and effective constants of equilibrium or stationary state of this reaction, catalyzed by free, dissociated and fixed E. coli cells. This study confirms the possibility of using this reaction to recover L-glutamic acid from L-aspartic acid. Figures 6; references 12: 7 Russian, 5 Western.
[76-10,657]

USSR UDC 547.963.3

USE OF A COMBINED SYSTEM OF TRANSCRIPTION-TRANSLATION TO CLARIFY THE ROLE OF CRYPTIC PLASMIDS OF BACILLUS THURINGIENSIS

Moscow MOLEKULARNAYA BIOLOGIYA in Russian Vol 13 No 6 Nov/Dec 79 pp 1230-1236 manuscript received 12 Dec 78

DEBABOV, V. G., LINDEMAN, L. F., KHLEBALINA, O. I. and KOTOVA, T. S., All Union Scientific Research Institute of Genetics and Selection of Industrial Microorganisms, Moscow

[Abstract] Bac. thuringiensis is an industrial producer of entomocide protein, a crystal protein. The latter is a crystalline inclusion in the organism and consists of several proteins, and makes up half of the total protein in the cell. Plasmids have been found (Debabov, 1977) in strains of Bac. thuringiensis which carry the crystal protein; their role is unknown and the present work inquired into the possibility that the plasmids carry the structural gene of the crystal protein. A cell-free system of E. coli transcription-translation was used in this inquiry; the source of the genetic information in it was the Bac, thuringiensis plasmids (Bac. thuringiensis var. galleriae, strain 612). In the cell-free, in vitro synthesis, the DNA of the plasmids of the organism served as a matrix and was shown to possess high matrix activity. However, immunochemical analysis of the polypeptides synthesized in vitro, in the DNA plasmid system, showed that this DNA does not direct the synthesis of the crystal protein. Figures 2; references 17: 5 Russian, 12 Western.
[105-8586]

USSR UDC 612.592.1

SOME INDICES OF A SYSTEM OF THERMAL REGULATION DURING ADAPTATION TO COLD UNDER POLAR CONDITIONS

Moscow FIZIOLOGIYA CHELOVEKA in Russian Vol 5 No 5, Sep/Oct 79 pp 931-933 manuscript received 10 Jul 77

YAKIMENKO, M. A., TKACHENKO, YE. YA., DIVERT, V. E. and FIL'KO, O. A., Institute of Clinical and Experimental Medicine, Siberian Branch of the USSR Academy of Medical Sciences, Novosibirsk

[Abstract] Inhabitants (males, aged 20-30) of Norilsk who had lived there no less than two years were the subjects of this study; two groups were involved, one which worked in the open air and another which worked in a heated area. Heat loss from the skin surface was measured by the weighted mean temperature of the skin. Integral indication of heat production in the body involved recording of total oxygen demand. Heat formation in skeletal musculature was measured by value of the electrical activity of the trapezius muscle. Measurement of the temperature center of the body was made in the external auditory meatus, 1-2 mm from the eardrum. Exposure to the extended action of cold lowered the weighted mean temperature of the skin, the level of thermoregulatory contractile activity of the skeletal muscles and the thermoregulatory increment in oxygen requirement. The adaptation was seen to involve lowering of the energy use mechanism lower temperature homeostasis in man. Small increments in oxygen demand, as low as 9-10%, were accompanied by intensification of the thermoregulatory contractile activity of muscles. References 13: 8 Russian, 5 Western.
[526-8586]

USSR UDC 612.82+612.17-612.46.7015.31.-003.96-019:599.323.4] (23)

EFFECTS OF MOUNTAINOUS CLIMATE ON BRAIN, HEART, AND KIDNEY ELECTROLYTE BALANCE IN RATS

Frunze IZVESTIYA AKADEMII NAUK KIRGIZSKOY SSR in Russian No 4, 1979 pp 48-54 manuscript received 9 Jan 79

(ALIYEV, M.A.; CHERNOOK, T.B.: KOSTYUCHENKO, L.S.; and LEMESHENKO, V.A.; Institute of High Altitute Physiology and Experimental Pathology, Kirgiz SSR Academy of Sciences)

[Abstract] Evaluations were made of physiological adaptation, in terms of electrolyte balance, of 180-200 g white male rats brought to an altitude of 1600 m at Issyk-Kul' and maintained there for a period of 40 days. Control data were obtained by use of rats maintained in Frunze. Determinations of

the K+ and Na+ values showed mean control values (in meq/100 g) of 16.6 and 28.1, respectively, for the midbrain; the respective values after 10, 20, 30, and 40 days in Issyk-Kul' were 16.0 and 11.1, 24.7 and 12.4, 19.6 and 7.5, and 29.0 and 22.4. In the case of the cerebral cortex, K+ and Na+ control values were 19 and 32.5; at the corresponding periods of adaptation the mean values were 14.1 and 12.5, 21.0 and 13.1, 24.3 and 9.4, and 36.7 and 23.2. These findings were interpreted to indicate adaptive changes and were tested by exposure of the animals to an altitude of 12000 m at a rate of 25 m/sec, or induction of thrombocyte aggregation by injection of 2.0 mg/kg of reserpine. In both situations, fluctuations in Na+ and K+ were mitigated to a degree corresponding to the length of adaptation at Issyk-Kul'. Somewhat analogous general findings pertained to the heart and the kidneys, which supported the contention that the changes induced in tissue K+ and Na+ levels by prolonged exposures to elevated altitudes represent adaptive parameters. References 10 (Russian).
[80-12172]

USSR UDC 612.577.462

YEARLY RHYTHMS OF THE CONTRACTILE FUNCTION OF THE HEART AND OF SOME INDICES OF CARDIAC METABOLISM

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 249 No 2 1979 pp 504-508
manuscript received 8 Jun 79

FROLOV, V. A., YEFIMOVA, L. V., KAZANSKAYA, T. A. and KOZYRENKO, V. N.,
University of Friendship of Peoples imeni Patrice Lumumba, Moscow

[Abstract] Citing several Soviet reports that circadian, seasonal and year-related biorhythms can affect the course of physiological and pathological bodily processes--possibly influencing outcome of disease or efficacy of therapy--the present article describes an experimental study--on chinchilla rabbits--of yearly rhythms of several very important aspects of cardiac activity. Measu ed were blood diastolic pressure in the aorta, peak systolic blood pressure in the cavity of the left ventricle during occlusion of the ascending aorta with subsequent calculation (Frolov, et al., 1975) of the coefficient of potential work capacity of the myocardium. Also assayed were content of free fatty acids in the blood, and lipoproteidlipase, triacylglycerolipase and monoacylglycerolipase activities, and myocardial fiber width. These data were collected in each month of the year and are tabulated. Data were processed on computers M-4030 and T1-58 and a simple analytical expression of the yearly rhythm of cardiac contractile power was derived and expressed as a mathematical function. The myocardium was functionally most effective in the period from beginning of spring to mid-summer, and least adaptive to load in the period from summer end to mid-winter. Figures 2; references 10: 7 Russian, 3 Western.
[110-8586]

USSR UDC 612.014.461+612.460

KIDNEY ADAPTATION TO HIGH ALTITUDES

Moscow FIZIOLOGIYA CHELOVEKA in Russian Vol 5 No 5 Sep/Oct 79 pp 849-854
manuscript received 22 Dec 77

KOROL'KOV, V. I., DOTSENKO, M. A., GRIGOR'YEV, A. I. and KOZYREVSKAYA, G.I.: "WWTER AND SALT EXCHANGE AND HUMAN KIDNEY FUNCTION AT HIGH ALTITUDES," Moscow

[Abstract] Differences which appear in individuals living in high mountain areas--with respect to lowered body weight, volume of circulating plasma, polyurea, excretion of electrolytes and osmotically-active substances, dehydration, shifts of water from intracellular to extracellular spaces--are cited. It is pointed out that these are found in individuals who normally reside at the high altitudes. The present article describes study of individuals who were gradually adapted to high altitude conditions. Six healthy males, 18-25, with the same level of training and resistance to hypoxia were subjected to an "ascent" in a barochamber to a height of 5000 m, with a 30-minute exposure. This was done over a 10-day period in a clinic of the Kirgiz State Medical Insitute in Frunze. Then the six were transported to a 2200 m height and, after this, to a 3200 m height--staying 12 days at each height. No special exercises were done at these times, and the six were returned for 10 days at the Frunze hospital. Daily calory intake was 3000 kcal; water intake was at will. Tests run included body weight, serum and urine Na and K, blood and urine osmotic concentration, gas exchange, acid-base equilibrium, hematocrit, circulating plasma, blood and urine creatinine, plasma renal flow, water intake and urine excretion. Under high altitude conditions, a relative increase was recorded in renal water losses and a decrease in water requirement, rise in rate of excretion of osmotically-active substances and sodium (especially at 3200 m); no substantial increase in rate of glomerular filtration or plasma flow was noted. Neuroendocrine regulation of water and salt exchange was reflected in a decrease in production of antidiuretic hormone and aldosterone. There was seen an increase in volume of circulating blood and erythrocytes, but essentially no change in volume of circulating plasma. The gradual adaptation apparently helped to prevent hypo-hydration. Figures 4; references 26: 8 Russian, 18 Western.
[526-8586]

USSR UDC 611.12:612.89

NOVIKOV, I. I., Institute of Physiology, Academy of Sciences Belorussian SSR

DEVELOPMENT OF HEART VALVE INNERVATION IN THE WHITE RAT

Minsk DOKLADY ADADEMII NAUK BSSR in Russian No 11, 1979 pp 1048-1051

[Abstract] Histochemical and fluorescent studies were conducted on the heart valves of embryonic, neonatal, young, and adult Wistar rats to determine the course and sequence of innervation. The results indicated that innervation commences during the first week of extrauterine life and that the process is essentially completed by the first month. Innervation was particularly pronounced in the case of the cuspid valves and suggested the presence of an intracardiac relfexogenic zone. In addition, rich adrenergic innervation was interpreted to indicate that the heart valves participate in catecholamine metabolism. Figures 2; References 10: 4 Russian, 6 Western.
[133-12172]

USSR UDC 615.33.035.4

EARLY ANTIBIOTIC USE IN MILITARY MEDICINE

Moscow ANTIBIOTIKI in Russian No 11, 1979 pp 873-875

[Article by Vspenskaya, T.A.: "Problems of Prophylaxis and Early Antibiotic Use (Plenary Session of the Committee on the Problems of "Antibiotics and Other Biologically Active Substances"), Moscow]

[Abstract] The plenary session on the prophylactic and early use of antibiotics was organized by the Institute for the Preparation of New Antibiotics of the Academy of Medical Sciences USSR and was held on April 16, 1979. The meeting was opened by Academician G.F. Gauze, who reported on international congresses and emphasized the need for early administration of antibiotics. G.K. Alekseyev spoke on "Certain Asepcts of the Use of Antibiotics" in which he emphasized prophylactic administration, and YU.G. Shaposhnikov and YE.A. Reshetnikov (Military Medical Faculty, Central Institute of Postgraduate Medicine, Ministry of Health USSR) covered the use of prophylactic antibiotic therapy in soldiers with open wounds under battle conditions. Other speakers on related themes includes YE.YE. Gogin, YE.S. Tikhomirov, V.G. Alekseyev, A.A. Khizhnyak, and N.V. Yefimov on antibacterial therapy of acute pneumonia, A.M. Marshak on the early use of antibiotics in surgery, and V.M. Mel'nikova on the use of antibiotics in various conditions that may result in gangrene.
[134-12172]

USSR

PROSTAGLANDINS: LEGENDS AND REALITY

Riga NAUKA I TEKHNIKA in Russian No 6, Jun 79 pp 20-21

Dikovskaya, Klara Ivanovna and Freymanis, Yanis Fritsevich, Prostaglandin Chemistry Laboratory, Institute of Organic Synthesis, Latvian SSR Academy of Sciences

[Abstract] Prostaglandins are bioregulators which have important uses in medicine and in livestock raising (regulation of fertility cycles, curing of barrenness, aborting karakul sheep to obtain unborn hides, increasing caviar production). Some 20 naturally-occurring prostaglandins are known, and chemical syntheses of some of them have been carried out. Currently interest focuses on prostaglandin homologs which do not occur in nature; some of these are not "recognized" and broken down by enzymes in the cell, so that their effects can last much longer. Some examples are 15-methyl PGF_2 and the PGF_2 analogs "equamate" and "extrumate," which surpass the activity of the natural compound by 10 and 100-200 times respectively. Prostaglandins are converted by enzymes into endoperoxides such as PGG_2 and PGH_2, which form thromboxanes in thrombocytes. The endoperoxides are also converted by enzymes to prostacyclins, which are secreted by blood-vessel walls when in contact with thrombocytes and which prevent their accumulation. Prostaglandin with cycloadenosine-3',5'-monophosphate has a central role in many regulatory mechanisms. The USSR is conducting the "Prostaglandin" all-union research project. PGE_2 is being biosynthetically produced by the Institute of Chemistry, Estonian SSR Academy of Sciences. Medical requirements for it are expected to be satisfied in the future. The Institute of Organic Synthesis, Latvian SSR Academy of Sciences, is working on a total chemical synthesis of prostaglandins so as to produce larger quantities in its experimental plant. It has produced 11-desoxy PGE_1, with a physiological activity comparable to PGE_1; this is being supplied to scientists for study. The Latvian Scientific Research Institute of Livestock Raising and Veterinary Medicine is studying the biological activity of these compounds. Figures 2. [37-8480]

USSR UDC 541.69+577.150.4+577.15/17+612.014.462+612.015+615.011

PRINCIPLES IN CLASSIFYING PHYSIOLOGICALLY ACTIVE SUBSTANCES

Moscow IZVESTIYA AKADEMII NAUK SSSR, SERIYA BIOLOGICHESKAYA in Russian No 5, Sep-Oct 79 pp 732-737 manuscript received 6 Apr 79

GLADKIKH, S. P., DMITRIYEVA, M. V., NIZHNIY, S. V., PIRUZYAN, L. A. and PODYMOV, V. K., Scientific Research Institute for Biological Testing of Chemical Compounds, Moscow

[Abstract] The usual methods of classifying physiologically active substances are unsuitable largely because the characteristics used as classifying features are based mainly on the clincial features of the therapeutic effect. To use these methods in screening systems, they should provide clear information from each level of the biological tests, from physicochemical to the total organism. A different approach is suggested for problems of classification of physiologically active substances with regard to the principles of interaction of the agent and target, i.e., on the mechanism of the effect. The organizational hierarchy of biological objects and functions of main systems is given from the molecular and submolecular to the systems level. Physiologically active substances are themselves classified as receptor types which act at the macromolecular and submolecular level and biochemical types which act as metabolites and chelate forming substances. The types of physiological activity for screening physiologically active substances at all levels of investigation and types of pharmacological and therapeutic activity may be classified as indirect only at a fundamental level such as the molecular level of the organism. To demonstrate the effect of physiologically active substances at the cellular level, caffeine in concentrations of 5.10^{-6} to 2.10^{-2} M revealed a two-phase effect on an isolated strip of myocardium of the frog. A brief increase in the amplitude of contractile responses without appreciable variation of the cellular potential of action was common for the first phase. The length of the potential of action decreased and the contractile activity was suppressed in the second phase. It was determined that caffeine significantly increases the Ca-current and reduces the threshold of its activation on a background of blockading the first channels by tetrodotoxin during the first phase. The slow component of the caffeine-modified incoming current is suppressed by D-600 compound. The electrical and contractile activity of the myocardium, completely suppressed by tetrodotoxin, is restored by caffeine and is not restored upon suppression of the Ca-current when using compound D-600. The results indicate that the effect of caffeine is related to its effect on the Capermeability of the cellular membrane and also the membranes of intracellular calcium pellets. The described effects differ significantly from the action of catecholamines on the same object and caffeine-possibly interacts with the so-called adrenergic receptor and has a different target distinct from it as well. The basis of the various types of physiologically active substances is physiochemical processes related to restructuring, variational

redistribution of the forces which stabilize the structure or individual fragments of the target due to the influence of the appropriate agents. Further development of the concepts on the mechanisms of changes in the tertiary, quaternary structure of active reception centers and catalytic centers of enzymes will lead to further differentiation of the mechanisms within each of the groups of physiologically active substances. All the mechanisms will be realized jointly at the cellular level and separation of them into components is rather arbitrary. The given systemization is suitable for working out models acceptable at the primary stage of selecting physiologically active substances by the forecasting principle. The differences of physiologically active substances within a group may be related to the characteristics of the effect of processes in which physiologically active substances participate on kinetic or equilibrium parameters. This also causes a difference in the methodical approaches to determining the main features of action of substances suitable under screening conditions at each of the organizational levels. References 7: 7 Russian.
[17-6521]

USSR UDC 612.821

POSSIBILITY OF DETERMINATION OF DIRECTION OF INFORMATION TRANSMISSION IN NEURAL NETWORKS

Moscow FIZIOLOGIYA CHELOVEKA in Russian Vol 5 No 5 Sep/Oct 79 pp 942-944
manuscript received 30 Sep 78

ANNARAUD, D. K., MATVEYEV, YU. K. and USOV, V. V., Institute of Experimental Medicine, USSR Academy of Medical Sciences, Leningrad

[Abstract] A method is suggested to identify the direction of information transmission in neuron ensembles in order to study changes in the neuronal communications. The basic idea of the method consists in examining, successively, two hypotheses; the first hypothesis suggests that a single event in a pulse current, B, is the sequela of single events in current A. A diagram of this hypothesis presented, wherein the events in current B are depicted as fully determined by events in current A (thus, a single pulse in A is followed by a discharge in B). The second hypothesis is the antithesis of the first. In the article's approach to this study, two fields of simultaneous neuron events were constructed in correspondence with these two hypotheses [the procedure for such construction is referenced but the reference itself is, in fact, not supplied in this article]; on the basis of the procedure it is apparently possible to identify forward and reverse, two-way, directions in the transfer of information. The procedure was used to study spontaneous activity of a pair of neurons, the activity being recorded by one or two microelectrodes. Spikes of the separate neurons were isolated by amplitude discrimination. Figures 2; references 7: 5 Russian, 2 Western.
[526-8586]

USSR UDC 616.12-009.72-085.849.19

TREATMENT OF ANGINA PECTORIS WITH HELIUM-NEON LASER

SHASTIN, N.N., AGOV, B.S., ZHUK, A.YE., and NIKOLAYEVA, R.I., Faculty

Moscow KLINICHESKAYA MEDITSINA in Russian No 19, 1979 pp 42-46

Chair of Therapy, Leningrad Sanitary-Medical Institute

[Abstract] Red light provided by a helium-neon laser (0.6328 um wavelength, 20-30 mW; 15-20 30 sec sessions), applied to the chest wall, was tested for therapeutic efficacy in the case of 66 male and female patients with angina pectoris, ranging in age from 40 to 76 years. Sixteen of the subjects received laser therapy alone, while 50 were also maintained on their regular drug regimen. Evaluation of the subjects showed that a positive therapeutic effect was obtained in 81.8% of the patients, espeically in those with lighter forms of angina pectoris. This was manifested by a decrease in the frequency of anginal attacks, shorter duration of pain, and greater tolerance of physical stress. In 75% of the cases improvements persisted for six to ten months. None of the subjects exposed to ordinary red light employed as a control evidenced any degree of improvement. Tables 1; References 8: 1 Western, 7 Russian.
[528-12172]

USSR UDC 611.71:539

MATHEMATICAL MODEL OF BONE TISSUE AS A POROUS, RESILIENT PIEZOELECTRIC MATERIAL

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 5, 1979 pp 851-855

[Articel by Yu. A. Avdeyev and S. A. Regirer, Institute of the Mechanics, Moscow State University Imeni V. V. Lomonosov]

[Abstract] A model of a porous material filled with piezoelectric fluid was proposed for the studies of bone tissue. A two phase statistically homogeneous system was analyzed consisting of a solid skeleton with piezoelectric properties and a viscose electrolyte filling the pores. The skeleton and the medium were anisotropic. Mass exchange between phases leading to a change in porosity was considered disregarding the diffusion and chemical reactions inside these phases. The analysis was limited to equal and constant phases of real density at identical phase temperatures and small skeleton deformations. The equations developed represented important characteristics of bone tissue: piezoelectric and pyroelectric effects, shifts

of the electrolyte in the pores, and ability to readjust under the influence of an electric field. When it is possible to disregard irreversible deformations and the effects of the changes in real density, these equations could be used for situations of a short lasting load on bone samples with rather high deformation rates. References 8: 4 Russian, 4 Western. [94-7813]

USSR UDC 615.361.12.041.41

PATHOPHYSIOLOGIC FEATURES OF BIOLOGICAL HEART PRESERVATION BY ROBICSEK'S METHOD

Moscow PATHOLCGICHESKAYA FIZIOLOGIYA I EKSPERIMENTAL'NAYA TERAPIYA in Russian No 5, 1979 pp 15-20

BARINOV, E.F., Chair of Operational Surgery and Topographic Anatomy, Donetsk Medical Institute imeni M. Gor'kiy, and the Gor'kiy Medical Institute imeni S.M. Kirov

[Abstract] Hemodynamic and histochemical studies were performed on heart-lung preparations of 40 dogs, in order to evaluate the pathophysiological aspects of Robicsek's method of heart preservation in absence of biochemical supportive measures. The survival time of the heart of 2-3 h under these conditions was determined by the development of pulmonary edema and hypertension, as well as right and left ventricular failure which curtailed adequate heart perfusion. Figures 3; References 12: 3 Western, 9 Russian. [119-12172]

USSR UDC 615.372:576.851.315/.032.3

ORAL CHEMICAL VACCINE FROM A TOXIGENIC STRAIN OF V. CHOLERAE, SEROVAR OGAWA. (AN EXPERIMENTAL STUDY)

Moscow ZHURNAL MIKROBIOLOGII, EPIDEMIOLOGII I IMMUNOBIOLOGII in Russian No 10 Oct 79 pp 62-68 manuscript received 30 Oct 78

DZHAPARIDZE, M. N., KARAYEVA, L. T., SUMAROKOV, A. A., PAVLOVA, L. P., MARCHUK, L. M., NAUMOV, A. V., POPOV, A. A., NIKITINA, G. P., IGONINA, N. B., YABLOKOVA, L. N. and KOTKINA, T. A., "Mikrob" All-Union Scientific Research Plague Control Institute, Saratov

[Abstract] Earlier, this institute had developed a chemical, tabletted vaccine, from strain No 569B V. cholerae of the Inaba serological type, for testing on volunteers in oral proprylaxis of cholera. It had been tried

in Bangladesh and the Philippines, whereupon the WHO concluded it was necessary to include--in cholera vaccines--antigens of both Ogawa and Inaba serological types since cross protective reactions between the two types were not indicated. The present article describes trials of a chemical, tabletted vaccine prepared from a centrifugate of a broth culture of strain No 41 p of V. cholera, serovar Ogawa. The subculture had been isolated [inferentially, by the authors' institute] from the vaccine strain No 41. Preparation details and standardization procedures are cited and substantiated. Using rabbits as test animals it was demonstrated that the oral vaccine was qualitatively equivalent--with respect to its low residual cholerogenicity and toxicity--to the oral vaccine from the strain No 569B whose safety and areactogenicity for people had been shown (see above). The oral vaccine was able to evoke, when administered intra-enterically, in rabbits, the formation of antitoxins and vibriocidic antibodies. Figure 1; references 17: 7 Russian, 10 Western.
[104-8586]

USSR UDC 615.332(Bleomycinum)].015.4.076.9

GOL'DBERG, L.YE., SHEPELEVTSEVA, N.G., VERTOGRADOVA, T.P., STEPANOVA, E.S., MURAVEYSKAYA, V.S., BELOVA, I.P., and FILIPPOS'YANTS, S.T., Institute for the Preparation of New Antibiotics, Academy of Medical Sciences USSR, Moscow

PHYSIOLOGICAL EFFECTS OF SOVIET BLECMYCIN--BLEOMYCETIN--ON MULTIPLE PARENTERAL ADMINISTRATION

Moscow ANTIBIOTIKI in Russian No 11, 1979 pp 847-853

[Abstract] Preclinical studies were conducted on chronic toxicity of bleomycetin--Soviet bleomycin--using rats (intramuscular administration), rabbits (intravenous), and dogs (intravenous). The use of various dosages and schedules demonstrated that the primary cause of death was glomerulonephritis, with possible secondary contributions from pulmonary involvement. The hematopoietic system and the liver were not involved, and changes noted on the EKG may have been due to pulmonary malfunction. The lack of hematopoietic effects distinguishes bleomycetin from the majority of antineoplastic agents. Tables 2; References 8: 2 Western, 6 Russian.
[134-12172]

USSR UDC 612.017.4:612.815.2

PRODUCTION OF AN ANTISERUM TO NEUROTOXIN-2 FROM VENOM OF COBRA NAJA NAJA OXLANA AND ITS INTERACTION WITH THE TOXIN

Leningrad ZHURNAL EVOLYUTSIONNOY BIOKHIMII I FIZIOLOGII [Journal of Evolutionary Biochemistry and Physiology] in Russian No 5, 1979, submitted 16 May 78, signed to press 28 Aug 79, pp 543-545

BORTNIK, A.T., and ROZANOV, S.I., Department of Problems of Memory of the USSR Academy of Sciences Institute of Biological Physics, Pushchino

[Abstract] An attempt to use immunochemical methods for detection of neurotoxin-2 from the Central Asia cobra (Naja naja oxiana), bound with acetylcholine receptors of the end plates of mouse diaphragm involved procurement of the neurotoxin-2 by immunization of Chinchilla rabbits by injection of 0.25 ml of the toxin directly into the popliteal lymph nodes and reimmunization 1 month later by injection of 10 mg. of the toxin in 1 ml of physiological solution into the limbic vein of the ear and by 5 mg. intramuscularly. In spite of the high sensitivity of the method strict specificity of the antiserum for the toxin and its interaction with NT-2 both in vivo and in vitro, neurotoxin bound with acetylcholine receptors could not be detected by the immunofluorescence method. It was assumed that the antigenic determinant of the toxin participates in the binding of NT-2 with the acetylcholine receptors "masking" the determinant and destroying its capacity to bind specific antibodies. References: 6; Figure: 1.
[99-2791]

USSR

PATHOGENICITY OF UNSTABLE L-FORMS OF BRUCELLAE AND THEIR REVERTANTS

Prague ZHURNAL GIGIYENY.EPIDEMIOLOGII MIKROBIOLOGII I IMMUNOLOGII in Russian Vol 23 No 2 1979 pp 120-124 manuscript received 28 Dec 76

GREKOVA, N. A., TOLMACHEVA, T. A. and VERSHILOVA, P. A., Institute of Epidemiology and Microbiology imeni N. F. Gamaleya, USSR Academy of Medical Sciences, Moscow

[Abstract] The authors have been studying the virulence (in guinea pigs) of L-forms of brucellae,--produced by extended passage on penicillin-containing media--,duration of their persistence in the animal body, and, also, their capacity for reversion. The L-forms were seen to have lost much virulence but did persist in the animal, they did retain a capacity for reversion and were highly resistant to antibiotics (1972,'74 and '75). This article

reports study of the pathogenicity of Br. abortus 870, after passage through penicillin media, and of cultures of revertants of the L-forms obtained in vitro and in vivo. The L-forms were weakly pathogenic, for guinea pigs, causing insignificant response reaction to the reticuloendothelial system; they did possess some toxicity. Revertants obtained in vitro approximated, in pathogenicity, that of the L-forms of the brucella; revertants obtained in vivo approximated the virulent character of the initial, virulent brucella. The authors suggest that the L-forms pose a potential danger to man and animals. References 22: 20 Russian, 2 Western.
[52-8586]

USSR UDC 615-381:576.851.214

NATURAL SELECTION OF THE NISIN-PRODUCING STREPTOCOCCUS LACTIS, MOSCOW STATE UNIVERSITY STRAIN

Moscow BIOLOGICHESKIYE NAUKI in Russian No 11 1979 pp 87-89 manuscript received 20 Jun 79

YEGORDOV, N. S., BARANOVA, I. P., VOLKOV, A. G., GRUSHINA, V. A., GOLIKOVA, T. I., ISAY, P. P., ISAY, YE. I., KOZLOVA, YU. I., KOLESNIKOVA, YE. YU., SIDORENKO, A. T. and SILAYEV, A. B. [Recommended by the Department of Microbiology, Moscow State University imeni M. V. Lomonosov]

[Abstract] This study was made to obtain a culture of Str. lactis which could synthesis a Soviet-made nisin antibiotic; the starting material was a nisin-producing Str. lactis MGU (Moscow State University) strain. Natural selection was employed to produce more-active strains from the antibiotic-producing strain. A total of 580 colonies were isolated and tested for biological activity. One homogeneous strain was isolated which did not exceed the initial strain activity but was stable in the synthesis of nisin at a quantity of 2000-2200 units R/ml. The natural selection involved cultivation of the original strain on a biosynthetic medium (1% glucose, 30 mg% yeast hydrolysate and salts) which contained 4000 to 16000 units R/ml as an additive. References 5 (Russian).
[108-8586]

USSR

QUANTITATIVE PATTERNS OF DEVELOPMENT OF ENDOGENOUS INFECTION IN AN IRRADIATED BODY

Prague ZHURNAL GIGIYENY EPIDEMIOLOGII MIKROBIOLOGII I IMMUNOLOGII in Russian Vol 23 No 2, 1979 pp 113-119 manuscript received 20 Apr 78

MAL'TSEV, V. W., Institute of Biophysics, USSR Ministry of Health, 123182 Moscow, Zhivopisnaya, 46, USSR

[Abstract] Materials used in the present study were collected from the literature and in the author's work. Results of experimental observations in the literature have been used to develop a formula, $y = a + bx$, designed to show quantitative patterns between dose of ionizing radiation received by an animal (mouse) and the endogenous infection afflicting that animal as a sequel of the applied irradiation. In this formula, y is the degree to which the endogenous infection is expressed, x is the radiation dose, and b is the angular coefficient characterizing the intensification of the endogenous infection with an increase in dose of radiation by 100 roentgens or rads; a is the value of y when $x = 0$. When the injury by the ionizing radiation led to death, as a consequence of a "bond-marrow" syndrome, a straight-line linear relationship was seen to exist between the dose and the expressivity of an endogenous infection; when the death was due to an "intestinal" syndrome, an inverse linear relation was seen to exist between the dose and the inoculation of the microorganisms from internal organs--in the latter case, the pathological action on the body is due to bacterial endotoxins forming in the rupture of microbial cells in the body. The infection and the toxemia substantially exacerbate the acute radiation illness. References 15: 8 Russian, 7 Western
[52-8586]

USSR UDC 577.3

EPR SPECTROSCOPY USED TO STUDY RADIATION DAMAGE TO DNA

Moscow DOKLADY AKADEMII NAUK SSSR in Russian, Vol 248, No 6, 1979 pp 164-pp 1464-1466

[Article by O. S. Avdeyeva. G. T. Rikhireva and M. K. Pulatova, Institute of Chemical Physics, USSR Academy of Sciences, Moscow]

[Abstract] The question of primary radiochemical processes and their role in development of postradiation changes in both the radiosensitive and radioresistant tissues is still open. To explore this question, a series

of -irradiated specimens of radioresistant organs (liver, kidneys, heart, muscle) and of radiosensitive ones (spleen, thymus and bone marrow) was studied by means of low temperature EPR spectroscopy. All EPR spectra were complex and represented the sum of the signals from radical products of the radiolysis of water and chemical cell components. On the basis of the analysis of experimental data, it was concluded that the appearance of the characteristic signal of TH, resulting from the H-adduct to thymine, could be used to indicate DNA damage in a complicated system. The thymine octet was observed at the increased temperature of the analyzed specimen, where protonization of the thymine anion radical took place with the formation of the H-adduct. The principal reactions responsible for the ensuing course of radiation damage were the reactions of electron capture. Figure 1, references 5: 4 Russian, 1 Western.
[96-7813]

USSR UDC 551.510.04

PREDICTION OF AIR POLLUTION LEVEL IN BAKU ON THE BASIS OF MULTIPLE GRAPHIC REGRESSION ANALYSIS

Baku DOKLADY AKADEMII NAUK AZERBAYDZHANSKOY SSR in Russian Vol 35 No 4, 1979 pp 61-65 manuscript received 5 Oct 78

GORCHIYEV, A.A. and SPIRINA, L.N., "KASPIY" Science Center

[Abstract] A graphic approach is presented for predicting air pollution based on parameter P = m/n, where m is the number of air samples in a day with pollutant(s) concentration(s) exceeding by a factor of 1.5 the mean seasonal air concentration of a given pollutant, and n is the total number of samples taken during the day. Calculations made in Baku for the pollutants CO, SO_2, and NO_2 individually and taken together showed that the mean annual P was ca. 0.2 during the 1968-1974 period. Values of P exceeding 0.2 indicate excessive air pollution, while those less than 0.2 indicate less than average pollution. Multiple graphic regression analyses of P with respect to meteorologic factors (prevailing wind velocities, temperature, etc.) for industrial and residential areas of Baku demonstrated P to be valid in predicting air pollution 85-90% of the time in residential areas, and ca. 80-85% accurate in the industrial areas depending on the season of the year. This approach is currently being utilized in predicting air quality in Baku. Figures 3; references 4 (Russian).
[74-12172]

USSR

UDC 596.893.10

ISOLATION OF WEST NILE AND SINDBIS VIRUSES FROM MIGRATORY BIRDS IN TADZHIKISTAN

Dushanbe DOKLADY AKADEMII NAUK TADZHIKSKOY SSR in Russian No 8, 1979 pp 507-509

ABDUSALYAMOV, I.A., Corresponding Member, Academy of Sciences Tadzhik SSR, L'VOV, D.K., Corresponding Member, Academy of Medical Sciences USSR, KOSTYUKOV, M.A., GORDEYEVA, Z.YE., DANIYAROV, O.A., GROMASHEVSKIY, V.L., BULYCHEV, V.P., MURATOV, R.SH., BEREZINA, L.K., SKVORTSOVA, T.K., KONDRASHINA, N., and PAK, T.P., Institute of Zoology and Parasitology, Academy of Sciences Tadzhik SSR, the Tadzhik Scientific Research Institute of Epidemiology and Hygiene, and the Institute of Virology, Academy of Medical Sciences

[Abstract] In 1977 studies were commenced in Tadzhikistan on the isolation of arboviruses from migratory birds. Examination of birds belonging to 67 species resulted in the isolation of four viruses: two were shown to be serologically related to West Nile virus and two to Sindbis virus. This communication represents the first report on the isolation of the West Nile and Sindbis viruses from migratory birds. Tables 1.
[117-12172]

USSR

UDC 616.981.455-036.21+616.981.455-084

CURRENT PROBLEMS OF THE NATURAL FOCAL NATURE OF TULAREMIA AND ITS PREVENTION

Moscow ZHURNAL MIKROBIOLOGII, EPIDEMIOLOGII I IMMUNOBIOLOGII in Russian No 10 Oct 79 pp 3-8 manuscript received 10 Nov 78

OLSUF'YEV, N. G., Institute of Epidemiology and Microbiology imeni Gamaleya, USSR Academy of Medical Sciences

[Abstract] Natural foci of tularemia exist in 14 of the 15 union republics of the USSR--the exception is the KirgizSSR. The foci extend from the Kola Peninsula, Kalingradskaya Oblast and Moldavian SSR, in the West, to the Chukotsk Peninsula, Kamchatka, Sakhalin, and the Khabarovsk and Primorskiy krays. The most northern focus is the Pyasina River in the Taymir Peninsula, the most southern is Kulyab in Tadzhikiston and Zangilan in Azerbaijan. This article cites locales in the Soviet Union where foci exist, the work on its causative agent, its taxonomy and separation into 3 races, drug sensitivity, natural sources of infection, species of animal vectors, transmitting ticks and geographical aspects. Epizootic patterns and biocenoses have been given considerable attention. Serological diagnostic methods and use of

prophylaxis with tularemia vaccine have had considerable success in its control. Plans for its future control include studies on nosogeography of infection, development of an understanding of necessary conditions for existence of foci and their ameliorization, protection by vaccination, natural immunity and epidemiology. It is suggested that in some cases, the USSR has had greater success in the title studies than have non-Soviet workers. References 14 (Russian).
[104-8586]

USSR

UDC 576.851.49

BIOLOGICAL PROPERTIES OF NEWCASTLE SHIGELLAS

Kiev MIKROBIOLOGICHESKIY ZHURNAL in Russian Vol 41, No 5, Sep/Oct 79 pp 535-537

[Article by L. V. Gusakova: (A Study of the Biological Properties of Newcastle Shigellas) Zaporozhskaya Oblast' Sanepid Station]

[Abstract] Newcastle shigellas, isolated from patients in Southern Ukraine during the period when Flexner shigellas were on the rise and Sonne shigellas were decreasing, were investigated in an attempt to determine some common characteristic, such as the biotype, colicinogenotype, etc., which could be used in differential diagnosis. In total, 737 strains were studied. They possessed pronounced biochemical activity - fermenting glucose, galactose, arabinose; and assimilated maltose, dulcite and sorbitol. They were classified as the biotype Boyd-88, according to the classical scheme of Edwards-Ewing. Freshly isolated Newcastle shigellas differed little from other types in their virulence and pathogenecity. Newcastle shigellas were resistant to tetracycline (90.5 percent) and to streptomycin (61.5 percent) Only 21.5 percent were resistant to levomycetin. References 11: 9 Russian, 1 Polish, 1 Western.
[101-7813]

USSR

COMPARATIVE STUDY OF THE EFFECTIVENESS OF PERORAL AND INTRANASAL IMMUNIZATION OF SCHOOLCHILDREN WITH LIVE ALLANTOIC INFLUENZA VACCINE

Prague ZHURNAL GIGIYENY EPIDEMIOLOGII MIKROBIOLOGII I IMMUNOLOGII in Russian Vol 23 No 2 1979 pp 174-179 manuscript received 7 Dec 77

KOVAL', T. A., ALEKSANDROVA, G. I., GRUNIS, A. M., IVANNIKOV, YU. G., MEDVEDEVA, T. YE., SYCHEV, S. V., SHAPOSHNIKOVA, R. P. and SMORODINTSEV, A. A., Department of Virology, Institure of Experimental Medicine, USSR Academy of Medical Sciences, Leningrad; All-Union Scientific-Research Institute of Influenza, USSR Ministry of Health, Leningrad

[Abstract] This study was undertaken in November-December, 1972; the children, 19,257, ranged in age from 7 to 15 years and were from 26 schools. The peroral immunization used a commercial live influenza vaccine from strains A/HongKong /1/68 (H3N2) and V/SSSR 69, prepared at the Leningrad SciRes Institute of Vaccines and Sera, MinHealth USSR, in 1972. The intranasal immunization used a vaccine from cold-adapted variants of the same strains, subjected to 17 and 60 passages at 28°. Monovaccines of the strains were prepared at the production department of the All-Union SciRes Inst. of Influenza, in correspondence with the State Institute of Standardization and Control of Medical Biological Preparations, MH USSR. Results confirmed earlier findings of complete safety and high immunogenic activity of the special variant of the intranasal vaccine. Peroral introduction of the live influenza vaccine, used in the USSR for active immunization of adults against influenza, also stimulated development of immunity, without a vaccinal reaction. The two modes of vaccination provided decrease in frequency of cases of influenza in an epidemic period. References 7: 6 Russian, 1 Western. (Aleksandrova's address is given as the Department of Virology, Institute of Experimental Medicine, USSR AMS 197022 Leningrad, Ulitsa Acad. I. P. Pavlov, 12 USSR).
[52-8586]

USSR UDC 616.915-036.22-02:615.371

INFLUENCE OF ACTIVE IMMUNIZATION ON PERIODICITY AND SEASONALITY OF MEASLES

Moscow ZHURNAL MIKROBIOLOGII, EPIDEMIOLOGII I IMMUNOBIOLOGII in Russian
No 10 Oct 79 pp 29-33 manuscript received 10 Feb 78

BOLOTOVSKIY, V. M., GELIKMAN, B. G., AUZINYA, A. V., GLINSKAYA, YE. V. and KIBRICK, L. I., Central Scientific Research Institute of Epidemiology, USSR Ministry of Health, Moscow

[Abstract] Because of a lack of agreement on how great has been the influence of immunization on measles periodicity and seasonality, an analysis has been made of official data on measles incidence from city and rayon sanepid stations (locality not given, except that the city is large--cases are given per 100,000 people). Years involved are i) the pre-vaccination period, 1958-1963; ii) selective immunization period, 1964-1969; and iii) mass vaccination period, 1970-1975. Figures presented depict number of cases over the 1958 to 1976 period, the seasonal spread of cases in the 3 periods, mean daily, monthly and yearly indices of cases in the 3 periods and, finally, the mean daily monthly cases before and after execution of mass immunization and the multiplicity factor of the decrease in incidence. No difference was noted in periodicity or seasonal prevalence in the first and second periods--cyclic rises in incidence occurred at intervals of 1-2 years, peaking in February to May and having its lowest point in August to September. After mass immunization, the interepidemic periods extended up to 7 years; during these periods, incidence shifted to spring and summer months, peaking in May; lowest point was in October. Mass immunization has not yet brought any change in the seasonal spread of incidence in the time of its cyclic rises. Figures 2; references 14: 13 Russian, 1 Western. [104-8586]

USSR

INFORMATION RETRIEVAL FOR A HUMAN ENGINEERING SERVICE

Moscow VESTNIK MOSKOVSKOGO UNIVERSITETA, SERIYA 14 PSIKHOLOGIYA in Russian No 3 Jul/Sep 79 pp 44-54 manuscript received 2 Apr 79

LUCHKOV, V. V.

[Abstract] One of the most important needs in the theoretical activity in Soviet engineering psychology (EP) is to work out theories of professionalization of EP and of the organizational problems of EP development. This article represents self-analysis of the subject. Growth of EP as a profession is seen as a multistage process requiring the interaction of industry, science and the state where EP-practitioners know how to organize scientific knowledge and to integrate their discipline into the social economy. On the basis of US experience, three groups of disciplines are seen as important elements: i) a complex of man-technology disciplines (human factors engineering, engineering psychology); ii) industrial-organization psychology and industrial engineering, iii) systems-technology and operations research. Distinctions must be made between the meanings of the language of such disciplines in the US and in the USSR. Need is seen to construct, in the USSR, a model of this discipline, an interdisciplinary model of EP; apparently this has been started. Since EP is an applied profession it demands translation of all available masses of information into a system of information. EP practitioners must search for a universal, organizational form of development and of professionalization of EP to provide normalization of processes of integration of knowledge of the human input, planning and development of the technology, its control or administration and a systematic growth in an engineering psychology treasury or dictionary, viz., an information retrieval system, an IRS. This IRS would have to provide self-knowledge for the EP profession and, consequently, application of its ability to other disciplines. References 9 (Russian).
[47-8586]

USSR

PSYCHOPHYSIOLOGICAL STRESS IN FLYING

Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 9 Sep 79 p 18-19

LICHAGIN, P., colonel, military pilot-sharpshooter and ALPATOV, I., colonel, medical service, candidate of medical sciences: "FLIGHT IS NOT STOPPED FOR A SECOND"

[Abstract] This is a general essay article. The authors illustrate, with examples of bombing exercises and formation flying, how very complex and what a split second effort a military pilot's job is. Absolute attention

to the elements of flying is demanded at all times. In the training program, place must be made for post-flight analysis of errors--an analysis which must avoid superficiality, must be prompt, must investigate in detail the physical and technical aspects for correcting errors and achieving the basic parameters of proper flying. Commanders and instructors must demand adherence to occupational work competence, proper rhythm, avoidance of tension even in presence of the unexpected. A truism is that flying is immediate, now, it stops for nothing—hence straying of attention to what has just happened, or just passed, will lead to mistakes. Special training of cadets for coordination of actions--setting up models of various complex situations which demand use of every reserve and of every available operational technique, training in simulated cabins, achievement of realism in simulation of problems. Physicians must participate; psychophysiological traits must be recorded, which could help to expose unstable qualities and, also, help to avoid the consequences of instability; analysis must be made of causes of emotional instability to institute preventive measures. (An accompanying photo shows a plane on an unspecified exercise).
[59-8586]

USSR

FLIGHT SAFETY DEMANDS CONSTANT ATTENTION. ROLE OF BIORHYTHMS

Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 8 1979 pp 42-43

ANNENKO, V., colonel, war pilot, first class and PEKSHEV, V., lt. colonel of the medical service

[Abstract] Effects of long distance flight schedules on plane crews considered. It is stated that most bodily systems function better in the daylight hours than at night. To avoid the loss of working capacity of Soviet airmen who are assigned to long distance flights, (which disrupt biorhythms), emphasis is placed on the need for adaptation training before the flight. For example, the desired adaptation can be achieved by having the airmen take their sleep, over a 3-5 day pre-flight period, and awaken one hour before flight time (to the east) or even later (for flights to the west)-leaving time for the essential pre-flight jobs. This would synchronize biorhythms to the new time belt. When time does not permit this adaptation, the airmen might be asked to execute their responsibilities--in the new time zone--in the morning hours (to the east) and in the evening hours (to the west) at least for a 2-3 day period of synchronizing. Round trip flights wouldn't require adaptation. The best condition for work, at the proper time of day, is assuring the very best preparation for the particular task. One of the ways to assure safety is perfection of the forms and methods of planning, organization and execution of long distance flights--using the advancements of science. Knowledge of the fundamentals of psychophysiology and biorhythmology, combining periodicity of daily working ability with the demands of the job, is a reliable basis for improvement of training.
[58-8586]

USSR UDC 612.82

STUDY OF HIGHER NERVOUS ACTIVITY WITH THE PNN-2 DEVICE

Moscow FIZIOLOGIYA CHELOVEKA in Russian Vol 5 No 5 Sep/Oct 79 pp 945-948
manuscript received 8 Jun 76

KOL'CHENKO, N. V., MOLDAVSKAYA, S. I. and TROSHIKHIN, V. A. (deceased), Institute of Physiology imeni A. A. Bogomolets, UkrSSR Academy of Sciences, Kiev

[Abstract] The PNN-2 [letters derived from its Russian-language description] is a device to study neuropsychic stress. The device had been developed, by the authors, in 1975 at the Experimental-Design Construction unit of their Kiev institute, following which a small series of the electronic-design instrument was prepared. It differed from earlier devices in that i) it could be used to measure a great number of indices which characterize the individual features and functional status of higher nervous activity and ii) it could determine more rapidly--4.5 min in contrast to 25-30 min with the previous device--the indices of functional lability of nervous processes and work-capacity of the brain. A photo of the device is given with its various features indicated. The PNN-2 measures the latent period of motor response to visual and sound stimuli--reaction of hands and feet, duration of response, response in a sequence of stimuli. The methodology employed is attributed to A. B. Khil'chenko (1958). Use of the device is compared with use of the previously-employed device, PPCh; results with each are tabulated. Reaction times to stimuli are suggested as a means to gain insight to lability of nervous processes. The device is felt to be useful in industrial production situations. Figure 1; references 4 (Russian)
[526-8856]

USSR

UDC 612.821

VEGETATIVE REACTIONS DURING VOLUNTARY CONTROL OF ALPHA RHYTHM

Moscow FIZIOLOGIYA CHELOVEKA in Russian Vol 5 No 5 Sep/Oct 79 pp 927-930
manuscript received 5 Dec 77

MARKMAN, V. G.: (DYNAMICS OF VEGETATIVE REACTIONS DURING VOLUNTARY CONTROL OF THE ALPHA RHYTHM) Institute of Physiology imeni I. P. Pavlov, USSR Academy of Sciences, Leningrad

[Abstract] Note is taken of the paucity of prior study of any connection between voluntary changes in the alpha rhythm and changes in vegetative indices. Markman had measured (1977) changes in intensity of the alpha

rhythm during arbitrary control, changes in frequency of cardiac contractions and in skin-galvanic responses at the same time; he then suggested that interaction in these parameters should occur, if at all, with a definite shift in time. The present study is an attempt to verify the suggestion. The procedure used was described in earlier reports (this journal Vol 3, No 3, 1977, p 464; Vol 3, No 3, 1977, p 490). It is apparently possible, with that procedure, to assess the degree of connection between changes in vegetative responses and in alpha rhythm in the process of training and the time of interaction between them. Two groups were used in this article: 5 individuals who had mastered the technique of increasing the alpha rhythm, and 5 who were not familiar with it. The ability, with feedback, to raise one's own alpha rhythm was coupled with a dynamic, correlated connection of the alpha rhythm with changes in the vegetative indices. Differences among the test subjects were attributed to differences in the functional organization of hypothalamo-cortical associations; these differences could serve as a criterion for selection of job applicants. Figure 1; references 8 (Russian).
[526-8586]

USSR

UDC 591.526:578.087.1

POPULATION DEGENERATION IN A RANDOM ENVIRONMENT

Moscow ZHURNAL OBSHCHEY BIOLOGII in Russian Vol 40, No 6, Nov/Dec 79 pp 851-859

[Article by Yu. M. Svirezhev and A. P. Sidorin, Computer Center, USSR Academy of Sciences, Moscow]

[Abstract] Population behavior under extreme strees represents an interesting problem. This study was devoted to the relationship between population degeneration and various parameters describing their behavior facing random disturbance. The Vol'terra model was used as the starting model of a population or association of various species, supplemented by additive effects of the "white noise" type with varying relationships between its intensity and the biomass of the species. The biomass of the species represents a random process determined by the parameters of a nonperturbed system and by the intensity of random fluctuations. Mathematical treatment of this model led to the biological interpretation that, in a single dimension case, the probability of the degeneration of a species depends on the relationship between the biomass and the intensity of y_0/o fluctuation, where y_0=relative biomass of the species and o=intensity of the random effect. When more than one species is involved, the degeneration problem depends on each biomass, the intensity of each effect and the relationship between them. Figure 1, references 7: 5 Russian, 2 Western.
[109-7813]

USSR UDC 616.89-072.8:061.6(049.2)

PSYCHOLOGICAL LABORATORIES

Moscow ZHURNAL NEVROPATOLOGII I PSIKHIATRII in Russian Vol 79 No 8 1979 pp 1119-1120

BLEYKHER, V. M., Kiev

[Abstract] This is a contribution to a discussion proposed by the source journal on the organizational character of ongoing work of psychological laboratories (PL) in psychiatric hospitals. (The source journal had kicked off the discussion by publication of an article by Zeygarik and Rubinshteyn, this journal, 1978, No 12, pp 1861-1863). Apparently PL have been set up at some installations due to the courageous initiative of the head physicians at the psychiatric hospitals; the author feels the PL are essential for rational organization of work and the professional growth of pathopsychologists. As for training of key personnel, medical graduates are not yet prepared in general and applied psychology. A PL should be at hand for the pathopsychologist who shouldn't have to consult a psychology faculty at a university. Use of testing is mentioned; the MMPI test is not objected to, but testing should not be confined to it alone (besides, evaluation of answers requires highly-qualified specialists). Training of pathopsychologists is insufficient (e.g., Kiev University has a lecture course of 68 hrs for pathological and neuropsychology, no laboratory or separate course in psychiatry). The author sees the psychologist--in contrast to the West --as only a helper of the psychotherapist; he objects to giving major responsibility, for rehabilitation of patients, to psychologists. Pathopsychologists should not be expected to give a clinical diagnosis (this is compared to asking a laboratory worker to diagnose a case on the basis of blood and spinal fluid lab tests). Numbers of psychologists to be assigned to laboratories is still an unsolved question which could be resolved by advice of competent Moscow and Leningrad laboratories, with due regard for local conditions. Also to be resolved is the legal status of pathopsychologists as well as their licensing. Organizational-methodological centers for psychopathology ought to be set up, not only in Moscow, but in the Union republic capitals. The UkrSSR Ministry of Health is presently planning such a center.
[22]

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LIFE SCIENCES

BIOMEDICAL AND BEHAVIORAL SCIENCES

No. 2

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USSR REPORT

LIFE SCIENCES

BIOMEDICAL AND BEHAVIORAL SCIENCES

No. 2

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ENVIRONMENTAL HAZARDS

RESULTS AND PROBLEMS OF THE MEDICAL SURVEILLANCE OF PERSONS WORKING WITH IONIZING-RADIATION SOURCES IN THE USSR

New York City PROCEEDINGS OF THE FOURTH INTERNATIONAL CONFERENCE ON THE PEACEFUL USES OF ATOMIC ENERGY in Russian Vol 11, 1972 pp 225-241

/Article by A.A. Letavet, A.K. Gus'kova, P.P. Lyarskiy and P.I.Moiseytsev USSR Academy of Medical Sciences, Moscow. E.I. Vorob'yev, USSR Ministry of Health, Moscow/

/Text/ Results of 15 years of observations indicate that radiation doses received by personnel of scientific and medical institutions, operators of reactors and of particle accelerators and of radiographs under ordinary conditions presently constitute one-half to one-tenth the maximum permissible dose. The intake of significant quantities of radioactive substances is practically impossible. Materials involving 6000 persons were subjected to detailed dynamic clinical-physiological study in comparison with adequate control groups.

The most adequate (for the given level of dose parameters) observations which permit a quantitative evaluation of the state of the resulting functions of basic critical organs and systems (hemodynamics and its regulation, cardiological and cytological methods and others) are evaluated. Situations in which there is a possibility of increased, most frequently variable radiation from external sources (transportation and reloading of sources, gamma-flow detection under field conditions, investigative installation of the critical mass of reactors) and the clinical manifestations characteristic of them are analyzed.

There are formulated fundamentally new questions of present-day medical examinations, which permit: clarification of the phenomenology of the initial adaptive syndrome of the reaction to radiation, acting in a complex with other occupational factors; the evaluation of the possibility and mechanisms of reparation after previously existing more intense radiation,

especially at dose levels, which cause sub-clinical lesions; substantiation of adopted standards not according to direct reactions but according to the criterion of remote after-effects of radiation.

Fundamental bases of legislation adopted in the USSR for protection of persons working with radiation sources in the national economy in comparison with the analogous International Convention No.115 MOT /International Labor Organization/ are listed and analyzed. Means of improving systems of medical and hygienic observations and possibilities of purposeful selection and summarization of information collected in different countries according to a unified program and necessary for ensuring extensive safe use of radiation for peaceful purposes are evaluated.

The steady increase of the number of specialists working with sources of ionizing radiations and also the extension of the terms of observation provide some results of medical-hygienic studies in this area and suggest means for further study of this question.

Nearly 15 years ago A.A. Letavet /1/, at the First Conference on the Use of Atomic Energy for Peaceful Purposes, in Geneva in 1955, described a system of governmental legislation and practical recommendations adopted in the USSR in this period in respect to types of work which involve radiation hazards. Later, the Soviet Union ratified Convention No. 115 of ILO concerning the protection of workers from ionizing radiation and confirmed the closeness of the principal positions of our country with all basic positions of this convention.

Thus, there now exists a real possibility for evaluating the basic practical results of use of actual scientific information obtained in the process of medical observation of workers exposed to radiation sources.

In this report, naturally, we are relying predominantly on experience accumulated by scientific research and practical medical institutions of the Soviet Union and constantly comparing it with analogous materials obtained by scientists of other countries.

A distinguishing feature of this period of production and use of radiation sources in different sectors of industry, medicine and scientific research in all countries is the steady increase in the number of persons who come into contact with radiation sources and the kinds of contacts with radiation, which are 150-200 percent respectively of the levels existing 10-15 years ago in the highly developed countries. The overall volume of use of radioisotope devices in the USSR has increased more than 3-fold in the last 5 years alone.

Analysis of reports of the USSR sanitation and epidemiological service and also similar departments of Canada (1963, 1966) /2,3/, France (1967) /4/, USA (1965) /5/, analysis of reports of the TsERN /CERN/ (1969) /6/ and, finally, the most complete summary presented by the Scientific Committee of the United Nations in 1970 /7/ on the problem of the percentage of the population coming into contact with radiation in their work, reveals the following important facts.

The percentage of persons occupationally exposed to radiation constitutes, at present, 1-2 percent of the total population, depending upon the level of development of the country. At the same time, the number of persons working in the atomic industry is 4-5 times less than those who use sources of radiation. The medical and science sectors, with the vast diversity of kinds of contact due to the nature of their activity, lead all other sectors in this regard. Many persons work with reactors intended for different purposes and their number is increasing. The general trend of increase of numbers and the relationship between individual occupational groups in different countries is closely related, which gives special importance to the following conclusions and recommendations /6, 10/.

Another important feature of the present period is the significant universal reduction of level of radiation achieved in the USSR and in other countries. In 90-99 percent of the workers, this quantity is 1/3 less than the accepted maximum permissible value of occupational effect. Only in 4-9 percent of the workers does occupational radiation constitute 1.5 - 5 R per annum from external sources and it exceeds this level in less than 1 percent.

Mean values, according to data of the cited report of the Scientific Committee of the UN /7/ for the majority of the sectors vary from 0.07 to 0.59 R/annum.

Analysis of numerous data accumulated by hygienists of the Soviet Union /8-10/ show that, for basic occupational groups of research reactors personnel, of charged particle accelerators attendants working on radiation monitoring and regulating devices, the level of radiation is, as a rule, 3-5 times lower than the accepted maximum permissible dose (PDD). Only in persons in certain occupations, involved in repair operations, who perform gamma-flaw detection and well logging under field conditions and also those working on experimental nuclear filters, does the dose of radiation approximate the permissible maximum, constituting from 2 - 4.5 roentgen equivalent man/year. (REM).

Many years of hygienic observations of work conditions during use of different types of nuclear reactors in the USSR indicate that they are

presently completely satisfactory. Under stable regimes of operation, the power of gamma-radiation constitutes 0.01 - 0.02 microR/second; the flows of thermal, intermediate and fast neutrons are 20-70; 10-15; 5-10 neutrons/cm^2·seconds, respectively. The content of active short-lived aerosols in the air of the basic production areas does not exceed 10^{-14} 10^{-13} Ki/liter (oxygen utilization factor) and that of long-lived - 10^{-15} Ki per liter.

The overall dose of radiation of personnel who service reactors involved in scientific research, according to the sum of all components of radiation (gamma, beta and neutrino), does not exceed 0.5 - 1 rems/year and only for a very small number of persons in the central hall, occupied in repair of technological channels and in working out the reactor regime, reaches 2.5 - 4.5 rem /year.

Analogous values (0.5 - 4.0 rems/year) are obtained during ongoing operation of different types of charged particle accelerators (synchrophasotron, synchrocyclotron, betatron), of powerful isotope gamma-devices, used widely for many radiochemical processes and "radiation" sterilization and also of some other highly-active sources of radiation (different types of research filter circuits used widely for physical and physical-chemical studies and analysis of the structure of substances).

The most unfavorable work, at present, from the hygienic point of view, is work involving industrial flaw detection, especially that which involves the use of portable apparatus. Exposure of personnel from these devices during some forms of manipulation is presently at the limit of permissible levels (3-5.5 rems/year). In stationary gamma-flaw detection, the exposure level is, at present, reduced to 0.8 - 1.5 rems/year.

Labor conditions of employees of medical roentgeno-radiological institutes are extremely diverse today. Figure 1 shows the change of the peripheral blood in roentgenologists, related to the formation of overall doses of radiation. Analysis of the dose levels for different types of procedures and periods of time, for which are possible accumulation of different overall values, in comparison with the potential danger of the rise of unfavorable remote after-effects, was undertaken by V.Ya. Golikov /11/. It was shown that, for the overwhelming majority of workers, with the exception of persons conducting special roentgenological and radiotherapeutic procedures (trochoscopy, angiopulmono-cardiography, stowing applicators and caring for radio-oncological patients), the overall dose and locally absorbed doses are lower than those whose effect could possibly lead to development of local changes of the integument (800-1200 rads) or to such remote unfavorable after-effects as an increase in frequency in the cases of leukemias and a shortening of life.

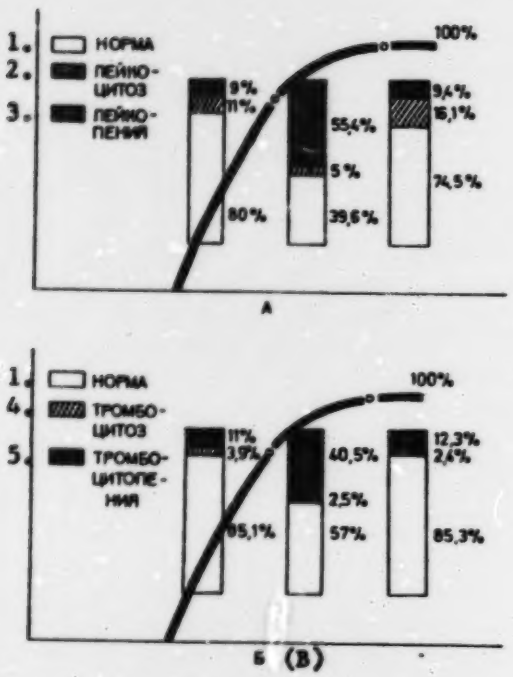

Figure 1. Assessment of radiologists according to indicators of the peripheral blood in different periods of work in comparison with the dynamics of formation of the overall dose exposure. On the curve is the relative dose value (in percent of the overall dose). In the columns is the relative number of persons with reduced, normal and increased number of leukocytes (A) and thrombocytes (B) in the peripheral blood.

Key:
1. Normal
2. Leukocytosis
3. Leukopenia
4. Thrombocytosis
5. Thrombocytopenia

In connection with the above mentioned general reduction of the radiation levels and the expansion of the area of use, there is being noted, in all countries, a gradual growth of the relative significance of non-radiation factors in the overall complex of effects of work conditions on the state of health of persons working with radiation sources. This should be considered both in the medico-hygienic examination and also during evaluation of the observations, especially the remote effects.

We must also note the appreciable increase in the average age of persons professionally associated with radiation inasmuch as changes in the state of their health, caused by physiological aging, intercurrent diseases and also some individual physiological and pathological states inherent to persons of different ages and sex, becomes more meaningful.

In standard documents adopted in past years in individual countries, the maximum permissible level of radiation was lowered gradually. These recommendations became more stable after 1960 and were not reconsidered to any great extent /12-14/.

Real possibilities of significantly reducing occupational radiation loading arose in the process of mastery of the technology. Thanks to this, even persons remaining at their previous work posts were subjected to noticeably reduced radiation levels and the overall dose is very unevenly distributed in the course of their long occupational activity /15-17/.

Differentiated analysis conducted by E.A. Denisova /18/, (1970) on individual groups of workers established that this excess never involves persons working on research and power reactors and the overall values of doses among them for the entire work time does not exceed 30 R. Among two-thirds of accelerator workers with a long period of service, the combined doses, at present, reach 80-100 R but, for more than one-half of the roentgenologists, they exceed 100 R.

Among medical radiologists who began work in the USSR in the last 10 years /19-23/, the combined doses, as a rule, are lower than 15-30 R with relatively uniform distribution for the entire period of their professional activity.

Reconstruction of distribution of dose loadings in time for all of these persons and especially for persons being exposed to combined radiation effect from different sources (contact with radium compounds, thorium and others) seems to us to be much more important than formal analysis of effects conducted only according to comparison with combined doses of occupational radiation.

In respect to the combined effect of some factors, a methodology of research involving a significant revision of some standing ideas is being formulated. It is enough to point out the complex evolution of opinions concerning the nature of diseases developing among miners who come into contact with ores containing admixtures of radioactive substances or in persons who produce and apply permanent luminous compounds containing radium-226, mesothorium and other substances to articles /24-27/. The basis of future extremely interesting studies in this direction should be improvement of methods of quantitative characteristics of each factor in different periods of observation, the creation of adequately precise methods of judgment concerning the function of basic damaged organs and systems, precise representation of the biological effect of individual components, constant clinical and radiometric comparisons with dose levels established for the given organ by an entire complex of factors and the establishment of the comparative significance of these or those components in different periods of observation.

We must point out that the concept "critical organ" in its proper interpretation remains an important base of reference in this kind of investigation.

It is interesting that this concept, being generated within the framework of the study of the biological effect of radioisotopes with selective distribution /28-29/, is beginning to be used effectively also for evaluation of changes, caused by radiation from external sources, especially with the unequal distribution of energy inside the body /30-33/.

Everything indicated above determines the following practical important considerations. The possibility of detection of developed clinical syndromes of chronic radiation sickness among occupational contingents presently is becoming highly improbable (A.K. Gus'kova, 1970).

Much rarer are cases of severe, general, acute radiation injuries which were discussed in reports of appropriate departments in the USA /5, 34/, Canada /35/ and England. Summary data were also presented at a symposium on accidents in Vienna in 1969 /36, 37/, in works by L.L. Sokolina /38/ (1970) and also in some other publications /39/.

A few cases of recognition of chronic radiation sickness involve limited numbers of persons who began to work many years ago. As a rule, there was found, in them, mild and obliterated forms of disease in the period of complete or partial recovery /40-43/.

Individual acute injuries recorded in publications in recent years show a predominance of cases caused by irregular radiation /44, 45/ or local forms;

in 9/10 of the cases there is evidence of serious violation by the personnel of the rules of work and not the consequence of defects of technology of the equipment, /46-53/.

The predominance of local changes is characteristic on the whole also for the contingent of patients of radiation sickness primarily registered in the last 10 years. Sub-clinical forms of these injuries are most frequent in materials of dispensary observation for certain occupational groups /20, 52, 54, 55/.

The clearly marked tendency in recent years to the predominant effect from external sources of radiation and, in any case, the more frequent determining role of the latter in comparison with the entrance of radioactive substances inside in the biological effects being observed is very interesting /38/.

If the reduction of frequency of cases of chronic and acute radiation sickness and reduction among them of the percentage of severe injuries is completely uniform for all countries, then this, regrettably, is not the case in respect to so-called accidents or emergency occupational situations as a whole. The frequency of cases of unforeseen radiation of personnel in larger than normal doses without leading to the rise of defined forms of radiation injuries but which require qualified expertise and rational labor arrangement is being maintained at the previous level or even increasing somewhat (summary data, presented at the Symposium on Accidents in Vienna in 1969, materials concerning incidents with radium in the USA /56/ and others).

The distribution of frequency of cases of exposure to high doses of radiation (without clinical manifestations of reactions, with the presence only of local and, of course, overall radiation injuries) is extremely characteristic and similar in materials presented by different countries. Among 76 cases of high radiation doses, summarized by L.L. Sokolin (1969) /38/, only one of the sufferers experienced acute radiation sickness of the 1st degree from non-uniform radiation. There were observed 23 cases of local injuries and, in the others, there occurred only an increase of the maximum levels of radiation without obvious clinical manifestations.

It is important to note that in some occupation related situations, (loss of the radiation source) a possible effect of emissions involves equally individuals from the population of different ages who do not have any idea about the degree of radiation hazard /34-38/. The tragic effects of such situations in one Mexican family has been reported many times in the periodical press (Gonzales and Berumen, 1963, /57/).

Results of analysis of all published clinical observations permit us to say that during an overall exposure dose of general radiation of 70-100 R and an intensity of radiation of less than 0.05 R/day, it is not possible to observe obvious symptoms of injury, even on the part of the most sensitive organs and systems (hematogenesis, crystalline lens and others). This refers to cases of momentary emission in the indicated dose, keeping in mind the evaluation of the dynamics of shifts in each individual subject.

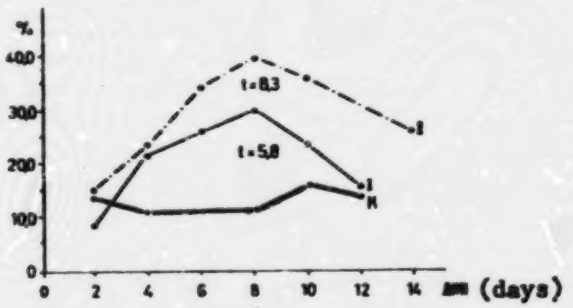

Figure 2. Frequency of the syndrome of neurocirculatory dystonia in different periods of observation in the control group (K) and in persons, who are subjected to occupational radiation in overall doses of 20-50 REM (I) and 70-100 REM (II).

However, even beginning from combined doses of 20-50 R (and more regularly during achievement of values of 70-100 R during use of special methods of clinical-physiological study) there can be noted in larger groups, in $\sim$ 4.5 of the cases, development of a clinical syndrome of expanded physiological reactivity of systems, which ensure adaptation of the organism to the conditions of the external environment. In its development is discerned a combination of effect of some factors which facilitate impairment of adaptational mechanisms of neuro-vascular regulation; neuropsychic or somatogenic asthenia in those above 40 years of age. Later, even during continuing exposure in doses which do not exceed 1-3 R/year, there occurs, in most cases, a smoothing out of manifestations of the indicated reactions, evaluated by us as orientational-adaptational reaction to the complex of all factors of the environment, including radiation. Merely as an example, there occurs a strengthening or even an inincrease of regulatory shifts in 17-24 percent of those examined. A hypotonic neutrocirculatory dystonia syndrome is being formed. In the other 3/4 to 4/5, there occurs a gradual convergence of frequency of shifts of individual indicators and of the syndrome as a whole with the limits of their variability in adequate control with only insignificant change during dynamic observation in the course of 6-8 years, being encountered in 12-14 percent of the persons examined.

This position may be shown by an appropriate illustration of the frequency of individual shifts in persons, who are subjected to radiation and in adequate control, during dynamic observation of them (Figure 2).

The facts presented above indicate how much the situation concerning persons occupationally associated with radiation was changed. Other and basic trends of scientific-practical and research activity must be initiated. The detection and diagnosis of developed forms of radiation sickness and the realization of therapeutic-prophylactic measures in respect to direct reactions to radiation can no longer be considered to be the basic task of periodic medical examinations as it was in the period of establishment of the atomic industry and in the initial period of use of radiation in the national economy /1/.

At the same time, definite progress in knowledge is being achieved and considerable practical experience is being accumulated in the area of the clinic of radiation reactions in man which permit more skillful and sound resolution of many disputed problems. Basic positions of this study, in particular, are based on materials of special clinical-physiological observations conducted by the Institute of Labor Hygiene and Occupational Diseases of the Academy of Medical Sciences and some other scientific collectives of more than 6000 persons working with radiation in medicine, at research reactors, particle accelerators, in industrial gamma-roentgenography and those having contact with radium compounds and other radioactive substances, being used in industry, agriculture and scientific institutions.

The basic results of this section of medical-hygienic study are:

a) detailed characteristics and evaluation of the significance of basic radiation factors in clinical manifestations in persons in occupations involving contact with radiation sources;

b) determination, on the basis of numerous clinical-hygienic comparisons, of the principles of dispensary observation of these persons, the real possibilities of the rise and the clinical variants of reactions caused by occupational radiation effect;

c) the accumulation of information concerning clinical criteria on the basis of maximum permissible levels of occupational radiation for groups of workers (according to the criterion of direct effects) and the development of a methodology of further study of this problem;

d) creation of a general pathogenetic classification and characteristics of basic forms of radiation sickness in man in different periods of its course;

e) assessment of the variability of standard indicators thanks to expansion of contingents and increase of the courses of observation for the so-called control groups, completely necessary for producing reliable information concerning regularities of shifts detected in persons subjected to radiation and the establishment of their connection with the effect of radiation /58-61/.

It is especially important to emphasize, in this group, the developments of the publications of V.V. Sokolov and I.A. Gribova (1969) concerning the indicators of the peripheral blood and the bone marrow of healthy persons, which include personal observations and critical analysis of extensive data from the literature concerning norms of blood cells, their variability and precision of the methods themselves of counting them.

E.A. Denisova's observations (1970) concerning the dynamics in the course of 6-8 years of basic indicators of the blood circulation and its regulation, studied with the help of a wide spectrum (more than 15) of methods among 220 healthy persons, deserve attention and require further development. There are shown typical (for 78-83 percent of those examined), boundaries of variations of basic indicators and courses when there appear in them marked deviations caused by an increase in age.

Significant support in the evaluation of the conditions of the eyes and, especially, the crystalline lens of persons subjected to the effect of radiation in the USSR, came from basic research in the dynamics of shifts in healthy persons of different ages, including those subjected to the effect of radiation. These studies were conducted in the USSR by N.A. Vishnevskiy and his students V.I. Abdulayeva, V.N. Stiksova, D.N. Kotova, E.A. Ivanova and Ye.N. L'vovskaya /62, 63, 64/ during 1959-1970.

This is illustrated by the most indicative graphs from extensive materials of control studies of the eye, including dynamic observations for the extent of 7 years for 200 healthy persons in comparison with analogous information for persons subjected to the effect of radiation. In these studies, it was shown that, with a sufficiently large number of observations (100's and 1000's of persons examined), the control indicators for persons of the same age group, indicate practically complete identity in the mean values of the force of accommodation, the dimensions of the physiological field of vision, the degree of dilatation of the pupils upon introduction into the conjunctival space of a 1 percent solution of homotropin, the value of the intra-ocular pressure and the pressure in the central artery of the retina and also the frequency of deviations in the condition of structures of the anterior section of the vessels of the eye and the crystalline lens. An increase in age of 5 years and more leads to reliable narrowing of the caliber and to an increase of pressure in the retinal vessels. An increase in the frequency of spot opacification

in all layers of the crystalline lens is seen in persons of the control group as early as after 3-5 years of observation with the use of a slot lamp but is not ascertained in these same periods in respect to the frequency of changes under the posterior capsule (Figure 3).

A distinction of the group of persons subjected to occupational related radiation in doses near PDD /maximum permissible doses/ from gamma-sources was the reliable tendency toward a reduction of pressure in the central artery of the retina (TsAS) upon attainment of overall exposure radiation doses of the order of 70-100 R (Figure 4).

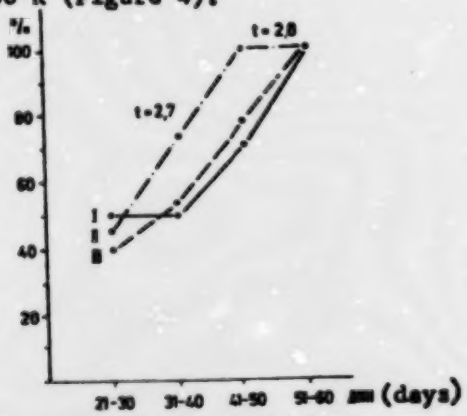

Figure 3. Frequency of changes in the crystalline lens in persons of different ages in the control group (I) in comparison with data concerning persons subjected to the effect of radiation in the range of 70-100 R (II) and 150-400 R (III).

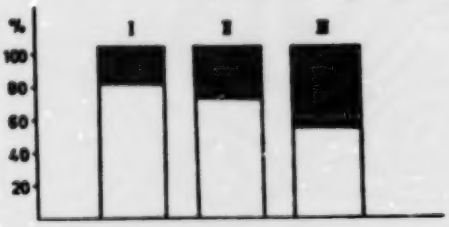

Figure 4. Frequency of cases of change of pressure in the artery of the retina in the control group (I) after radiation exposure in the overall dose of 70-100 R (II) and 150-400 R (III).

- Normal pressure in the central artery of the retina
- High pressure in the central artery of the retina
- Low pressure in the central artery of the retina

After radiation exposure in a dose of 150-400 R there was observed (more regularly in persons in the older age groups) some increase of frequency of spot opacities in vacuoles under the posterior capsule of the crystalline lens. There also appeared a certain tendency to acceleration of signs of physiological involution of the eye including a greater frequency of age-related cataracts than in the adequate control.

Only investigations of this nature can, in our opinion, provide an argued evaluation of the diagnostic significance of this or that shift and may be recommended representative courses of observation and proper evaluation of the contribution of occupation related radiation effect in the complex of effects acting on the dynamics of these or those deviations in the appropriate groups of persons.

Everything stated above indicates that a basic question at present is the creation of a reasoned system of purposeful medical examination which includes all persons who come into contact with radiation in their occupation.

It is advisable to differentiate the contingents and to determine the necessary volume, terms of observation and also possible yield of scientific information on the following bases.

For the significant part of workers, exposed all year to a radiation dose level of less than 1/3 the presently accepted PDD, there is, basically, no necessity (as is provided for by norms of radiation hazard) in a specialized examination to reveal indications of effects of radiation. On the first plane, for this category of persons, there emerge problems inherent in the principles of prophylactic observation adopted in the USSR and pursuing general medical purposes of prevention and timely treatment of some diseases, including those which prevent further work with radiation. The accumulation of comparative information on individual sectors of industry with a sufficiently large number of contingents and the study, among them, of the possible effect of low levels of radiations on general morbidity, mortality and the course of different general pathological and physiological processes (infectious diseases, tumors, pregnancy, age, the state of health of children, etc.) is of scientific interest.

Orientational counting of dose levels and forms of effect in this contingent (osteotrophic or hepatotrophic radiation, the overall external radiation, the effect on the skin of sources with low energies of generation) will permit further differential analysis of the contribution of the non-specific effect of radiation in the rise of syndromes of injury of critical organs and structures of man which syndromes are polyetiological in origin.

For the group of persons with radiation dose level from 1/3 to 1 PDD and near to PDD, it is advisable to maintain, in the light of present-day experience, more extensive differential observations once a year according to the radiation profile for the purposes of:

a) objective diagnosis of sub-clinical forms of reaction to the effect of radiation (mainly as a stimulus) and establishment of the possible effect of these shifts on the general and special capacity to work of personnel. There is also required the increase of precision and the possible connection of these shifts with processes being reflected under large overall doses of narrower effect of radiation as the damaging agent;

b) further clinical substantiation of accepted PDD of radiation dose according to the criterion of both direct and remote unfavorable effects of the occupational effect of radiation;

c) prevention of remote after-effects of radiation, the relatively low levels of which do not lead to noticeable direct effects.

For groups of persons, who were subjected, in the past, to radiation in doses which exceed the presently accepted permissible doses, who are suffering from radiation sickness or who are receiving a high dose of unforeseen radiation, very careful examination is performed at times and in amounts, dictated by clinical indications and also by the nature of the radiation (dynamics of formation of the dose load and distribution of absorbed energy inside the body).

Scientific information in this category of persons may provide important information:

a) on the dynamics of processes of radiation injury and recovery in different organs and systems of man;

b) on the nature and frequency of remote after-effects and outcomes after irradiation in a wide range of doses;

c) on the scientific argumentation of important practical problems of threshold levels of injurious doses;

d) on possibilities of rational labor layout and use of occupational classification of persons, who were previously subjected to a high dose of radiation or who suffer from different forms of radiation sickness.

In the USSR, there are some legal documents which regulate the basic aspects of ensuring radiation safety and some special recommendations are created concerning the organization of medical-hygienic observation in different sectors of the national economy. However, the improvement of legislation and its scientific substantiation are presently priority items in the work of leading scientific research institutions of the Soviet Union and its national commission on radiation protection. In addition to general acts of legislation concerning this or that aspect of human labor, there were adopted in recent years in the USSR some departmental rules and also particular methodical instructions for individual sectors, most complex situations or numerically important occupational groups.

This kind of material helps practicing physicians who conduct sanitation inspection and medical surveillance of persons working on reactors, accelerators, in medical and industrial gamma-graphy and radiography, with exposed isotopes of gold, phosphorus, iodine radium and others. They include, as a rule:

a) a brief written reference concerning the volume of information accumulated concerning a given occupational group;

b) typical characteristics of the level of influential factors and their possible biological action;

c) evaluation of potential sources of possible high radiation dose of a given professional group;

d) selection of adequate and accessible methodical means of study according to the real level of doses, typical radiation and also with norms of variability of recommended indicators in healthy persons;

e) description of clinical features which are possible in cases of high radiation from a given type of sources of forms of radiation sicknesses and reactions of individual organs and systems;

f) instructions on rational labor layout and expertise in cases of occupation related diseases and diseases not related to the occupation of a given contingent;

g) most advisable forms of registration, calculation and development of the data obtained.

As was indicated above, considering the relative rarity of such cases, the urgency of accumulating information collected into a unified plan and simultaneous rapid and operational, qualified decision making, the so-called "accidents" and 'emergency cases' in the area of producing and

using radiation sources require special clarification. Two instructional-methodical documents which include organizational formulation of a system of investigation and principles of rendering emergency assistance and prophylaxis measures in cases of high doses of radiation from internal and external sources were prepared by a group of scientific research institutes for these purposes in the USSR and were adopted and confirmed by the Ministry of Health.

The necessary scientifically reasoned refinement of definition concerning the practice of expertise and the preferential protection of persons working with sources of ionizing radiations in the USSR are also introduced into a general document concerning preliminary (upon beginning work) and periodical medical examination of workers, which document is confirmed by Decree of the USSR Ministry of Health No. 400 of 30 May 1960 with concurrence of the secretariat of the VTsSPS /All-Union Central Council of Trade Unions/. A list of occupational diseases, confirmed by the USSR Ministry of Health and VTsSPS on 25-26 February 1970 was determined. Instructions for its use include not only acute but also chronic radiation sickness and local radiation injury (p 19a, b, c). The possible connection between the effect of radiation and certain forms of tumors of the skin, bones and lungs (p 12, c, d and e) and also radiation cataracts (p 21a) is legally contended.

At the same time, there is urgent need for further improvement of legislation in the USSR in connection with the rapid growth of knowledge in the area of radiation medicine and the undeviating expansion of the sphere of use of radiation in the economies of all highly developed countries.

Most vital aspects in the plan of further scientific investigations on problems of radiation, intended to make a specific economic contribution to the use of radiation for peaceful purposes are:

a) Selection of more adequate quantitative methods of objective registration of sub-clinical shifts in basic critical organs and systems, depending on the nature and dose of radiation effect. It includes some special methods of study of the function of the liver, muscles, hematogenesis, overall adaptive syndrome, reception indicators, motor system and hemodynamics. In addition to purely practical purposes, improvement of diagnostics and determination of rational volume and courses of observation, this will facilitate progress in the general theory of radiobiology in respect to its most complex division, that concerning man /65-68/.

b) More extensive and more purposeful study of the significance of the initial background of activity of non-specific systems which adapt the organism to the external environment and also the state of

critical organs in subsequent reaction to radiation -- as a scientific basis of occupational selection and non-specific prophylaxis of radiation injuries and the remote after-effects of radiation.

c) Rationalization and determination of the volume of effective dosimetric control of radiation safety of persons of different occupations.

d) Study of the most unfavorable sections and forms of work capable of being potential sources of high doses of radiation and the development of all regulations for conducting effective urgent measures during accidents, including adequate dosimetry, routine diagnosis and necessary assistance to sufferers and also measures for eliminating accidents.

e) Further intensification and approximation of dosimetric characteristics to the biological object, especially to man, for obtaining more adequate clinical-radiometric comparisons which facilitate development of the theory of radiobiology in respect to the effect of radiations on man and also the creation of mathematical models which predict possible injuries and which evaluate quantitatively the effectiveness of different therapeutic-prophylactic agents.

f) A study of possibilities of unification of methods of study and statistical methods of processing information on the effect of radiation under occupational conditions which can provide data in a form suitable for machine processing.

Thereby becomes possible the rapid reception of necessary information for individual sectors of industry and for the country as a whole. This information may provide an authentic scientific base for operative planning and coordination of the work of practical institutions, which are involved in problems of radiation safety of persons working with radiations in different countries. They are, in our opinion, a necessary medical component of a system of measures, intended to give mankind not only economically essential resources in the form of wide use of the energy of ionizing radiations for peaceful purposes but also making its use practically safe.

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REMOVAL OF RADIOACTIVE IODINE FROM GASES

New York City PROCEEDINGS OF THE FOURTH INTERNATIONAL CONFERENCE ON THE PEACEFUL USES OF ATOMIC ENERGY in Russian Vol 11,1972 pp 399-413

[Article by I. Ye. Nakhutin, N. M. Smirnova, V. M. Makarov, G. A. Loshakov, G. A. Laushkina and V. I. Yaroshinskiy, USSR State Committee for the Use of Atomic Energy, Moscow, Union of Soviet Socialist Republics]

[Text] Introduction

The problem of removing radioactive iodine from gases has been discussed in the literature for many years, and it is still a pressing one. Detection of many iodine compounds present in the gas phase adds more complications.

This problem can be divided into two parts, that are virtually unrelated to one another: 1) Removal of iodine from aggressive gases (particularly from those containing nitrogen oxides); 2) removal of iodine from air and other nonaggressive gases.

In both cases, one has to take into consideration the origin of the gases to be treated, since their chemical composition, specific activity, etc., are related to their origin. We submit below the results of some studies on the behavior of iodine in aqueous and nitrate solutions, and about the compounds that iodine forms.

1. Behavior of Iodine in Aqueous and Nitrate Solutions

When nuclear fuel is dissolved, 20 to 80% of the radioiodine remains in the aqueous phase [1, 2]. The amount of radioiodine remaining in the solution depends on the type of fuel, mode of dissolution, equipment used in the process and total iodine content in the nuclear fuel. In order to determine the patterns of distribution of radioiodine in the solution and gas phase, a thermodynamic estimate was made of levels of iodine in different forms, as related to its overall concentration in aqueous solution (with consideration of dissociation of molecular iodine, forming: I^-, I_3^-, I^+, HIO, IO_3 and IO_3^-).

Studies of the kinetics of blowing iodine out of aqueous solutions (Figure 1) revealed that the removal of molecular iodine (I_2) with bubbling air is a first order reaction, while removal of the part of iodine present in the original solution in ionic form (when there are no redox agents) can be described satisfactorily by an equation or a second order reaction:

$$Q_\tau = Q_0^{I_2} e^{-\alpha\gamma\tau} + \frac{Q_0^{ion}}{1 + \frac{1}{2} K \cdot Q_0^{ion} \cdot \tau} \qquad (1)$$

where Q_τ is the concentration of iodine in solution at time τ, $Q_0^{I_2}$ is the initial concentration of molecular iodine in the solution, α is the coefficient of distribution of molecular iodine (I_2) in the gas and liquid phases at given temperature, γ is the coefficient that refers to intensity of bubbling and degree of equilibrium between the gas and liquid, Q_0^{ion} is the initial concentration of ionic forms of iodine in the solution, and K is the constant of rate of association of ionic forms, which equals 0.661 $\ell \cdot$g-equiv$^{-1} \cdot$min^{-1} at 80°C.

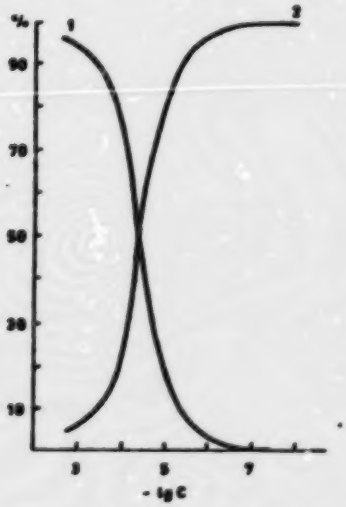

Figure 1.
Change in molecular (1) and ionic (2) forms of iodine content as a function of total concentration of iodine in aqueous solution

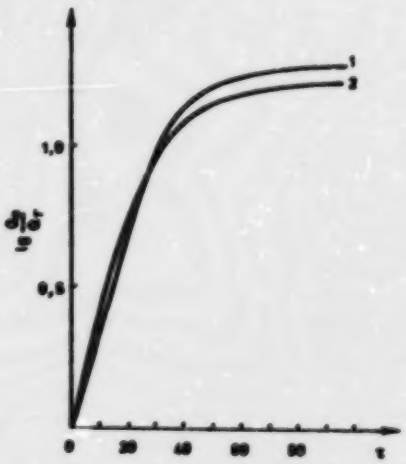

Figure 2.
Kinetics of blow-off of iodine from aqueous solution
1) experimental curve
2) theoretical curve
$Q_0 = Q_0^{I_2} + Q_0^{ion}$ —total initial concentration of iodine
Q_τ) iodine concentration at time τ

Figure 2 illustrates the experimental and theoretical curves for blow-off of iodine from aqueous solution at 80°C and initial total concentration of iodine of $1.12 \cdot 10^{-3}$ g-eq/ℓ.

A satisfactory conformity of estimated and experimental data was obtained as well for blowing iodine out of nitrous oxide solutions. However, the amount of radioiodine remaining in solution after dissolution of nuclear fuel was considerably greater than estimated. Evidently, this result is attributable to occurrence of chemical reactions of iodine during dissolution of nuclear fuel, which were not taken into consideration in the estimates.

The assumption has been made in the literature, to interpret the behavior of radioiodine, that there may be formation of iodine alkyls (in particlar CH_3I), presence in appreciable quantities of a number of unstable compounds such as HIO, HIO_2, INO, INO_2 and INO_3, or accumulation in an oxidative medium of iodine compounds with a high degree of oxidation of IO_3^- or IO_4^- [3-8].

However, none of the mentioned works submitted convincing evidence of the presence of significant amounts of the above-mentioned compounds in the solutions.

In virtually all types of nuclear fuels, there is a carbonitride phase [9-11]. We conducted experiments to determine removal of iodine from solution during dissolution of various materials containing a carbonitride phase, in nitric acid with addition of I_2.

The experiments were conducted with soft iron, tool steel, pig iron, metal uranium and uranium carbonitrides differing in composition. It was established that volatility of iodine decreased and levels thereof in condensates increased with increase in carbonitride phase in the material being dissolved. By means of repeated distillation, a clear, crystalline, readily volatilized iodine compound was isolated from condensates with high iodine content. The results of chemical analysis and studies of infrared spectra revealed that the isolated compound was cyanogen iodide, ICN.

Table 1 lists some data on yield of ICN upon dissolution of various materials in nitric acid containing an excess of I_2.

On the basis of the results of this study, it was established that radioiodine may be present in solutions of nuclear fuel in the form of ICN, I_2 and products of dissociation thereof.

Of the products of dissociation in nitrate media, HIO_3 is the most significant.

During extraction, because of the high solubility of molecular iodine in diluent and formation of a tributyl phosphate—I_2 complex [12] (analogous

complexes are also formed with amines), it changes almost entirely into the organic phase. It is known that I_2 interacts with unsaturated hydrocarbons, forming iodinated hydrocarbons [13]. In the presence of electron acceptors or under the influence of light or radiation, I_2 also interacts with saturated and aromatic hydrocarbons [14-16]. We studied the kinetics of formation of a crude [technical-grade] mixture of saturated hydrocarbons (C_9-C_{15}) in a two-phase system, in the presence of iodine solutions in nitric acid. The rate of iodination can be described by the following equation:

$$V = K \cdot c_{I_2}^{1/2} \cdot a_{HNO_3}^{1/2} \qquad (2)$$

where c_{I_2} is the concentration of iodine in the organic phase, a_{HNO_3} is activity of undissociated HNO_3 in the aqueous phase, and K is the constant of the reaction rate, which equals $1.75 \cdot 10^{-3}$ ℓ/min^{-1} at 20°C.

Table 1. Yield of ICN during dissolution of materials in HNO_3 containing an excess of I_2

Material dissolved	N and C content, g-atom/g-atom metal		ICN yield g-mole/g-atom metal
	N	C	
Soft iron	not analyzed	$4.15 \cdot 10^{-3}$	$6.2 \cdot 10^{-4}$
Tool steel	not analyzed	$6.74 \cdot 10^{-2}$	$5 \cdot 10^{-3}$
Uranium metal, sample No 1	$\sim 8.5 \cdot 10^{-4}$	$1.33 \cdot 10^{-2}$	$2.8 \cdot 10^{-4}$
Uranium metal, sample No 2	$\sim 9 \cdot 10^{-4}$	$3.23 \cdot 10^{-2}$	$5.6 \cdot 10^{-4}$
Uranium carbonitride $UC_{0.62}N_{0.38}$	0.38	0,62	$2.88 \cdot 10^{-2}$

In the presence of TBP [tributyl phosphate] and high-power radiation fields, iodination increases. To reduce accumulation of iodine alkyls in mixture of TBP with diluent, I_2 must be removed from aqueous solutions of nuclear fuel that are to be submitted to extraction.

Iodic acid HIO forms monosolvate with TBP, and the constant of extraction from nitrate solutions is 1.8 ℓ/mole at 20°C.

Cyanogen iodide ICN forms the complex TBP·ICN with TBP, and the extraction constant is 35 ℓ/mole at 20°C. Cyanogen iodide and the complex thereof with TBP are dissociated in alkaline media.

2. Methods of Removing Iodine

2.1. A paper was delivered at one of the conferences [17] pertaining to the use of iodine columns with $AgNO_3$ to trap iodine discharged upon processing of irradiated fuel, in which flaws were reported in the operation of such columns, related to solubility of $AgNO_3$ in water and its fusibility. In 1964, we developed columns for isotope exchange with $Ag^{127}I$, applied to the packing of the column. The advantage of such columns is that AgI is virtually insoluble. Such columns operate on the principle of "permanent" columns, since there is radioactive decay of iodine in silver iodide, along with absorption of radioactive iodine by silver iodide.

We previously derived equations for "permanent" columns for the case of gas-adsorption chromatography [18]. The equations for isotope exchange columns are analogous. According to these equations, there is stationary distribution of concentrations in the column, so that there is exponential decline of concentration of radioactive iodine toward the outlet from the column. The exponent depends on the velocity of gas in the column and rate of mass exchange between gas and solid AgI.

$$c(x) = c_0 \exp\left[-\frac{\lambda \cdot \varphi}{V} \cdot x\right] \tag{3}$$

where c(x) is the concentration of radioactive iodine at distance "x" from the entrance into the column, c_0 is the concentration of radioactive iodine at entrance into column, λ is the constant of radioactive isotope decay and ϕ is the function describing conditions of mass exchange and radioactive decay in the column; ϕ is unrelated to "c" and "x".

If a high enough value is given to the exponent, a good coefficient of purification can be obtained.

In such a column, the moving force is the difference in isotope concentrations of $Ag^{127}I$ and mixture of isotopes of iodine in the gas phase. The process of equalization of concentrations in the periodically operating column is associated with increase in entropy and, in principle, it does not require exogenous operations. However, in the "permanent" column, it is imperative to keep the difference between concentrations constant to assure continuous operation of the column. This is achieved by the process of radioactive decay.

Apparently, there is no obstruction to passage of stable ^{127}I through the column of isotope exchange, with the exception of a small part thereof, which is expended on the reaction of silver formed after decay of ^{131}I in compound $Ag^{131}I$ in the column packing.

A stationary state is established in the column within a certain time. The transitory processes occurring before establishment of the stationary state can be described as follows: first a chromatographic front is formed in the column, which conforms with equations of frontal chromatography of substances. It is assumed that the time of front formation is considerably shorter than the half-life of the substance, and this is valid in almost all cases, with the exception of very short-lived isotopes. As the front advances through the column, the influence of radioactive decay begins to be felt; for this reason the rear part of the front is an exponent, instead of the straight horizontal line of ordinary frontal chromatography (Figure 3).

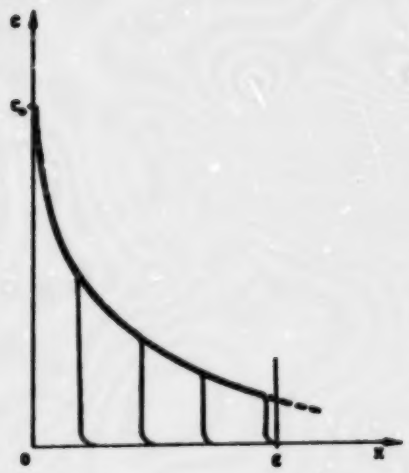

Figure 3.
Advance of front of decaying radioactive substance through column
X) distance from entrance to column
c) concentration of substance

Accordingly the height of the steep part of the front diminishes. One can disregard the influence of radioactive decay on the shape of the steep part of the front. When the advancing steep part of the front reaches the end of the column it is very short, and it is only after it exits from the column that a stationary state is established in the steep part of the front.

The time of establishment of a stationary state is:

$$\tau \sim \frac{Q}{q} \qquad (4)$$

where Q is capacity of column for a given substance and q is amount of substance entering the column per unit time.

The following condition must be satisfied to assure high coefficients of purification:

$$\tau \gg T_{\frac{1}{2}} \qquad (5)$$

where $T_{\frac{1}{2}}$ is the half-life of the radioactive substance.

The solid phase is involved in isotope exchange in the column. Since processes are much slower in the solid phase than the gase phase, one must disperse AgI to assure efficient operation of the column, in order to provide a larger surface and shorter diffusion route in solid particles. Use of sorbent in the pores satisfies these requirements.

Figure 4 illustrates the distribution of radioactive iodine along the isotope exchange column at t = 150°C. The logarithm of concentration in arbitrary units is plotted on the y-axis and distance from entrance into column on the x-axis. The concentration decreases by more than 10,000 times at a distance of 14 cm.

Experiments involving addition of AgI to large-pore sorbent with pore size of 75÷100 Å illustrate the extent of dispersion (Figure 5).

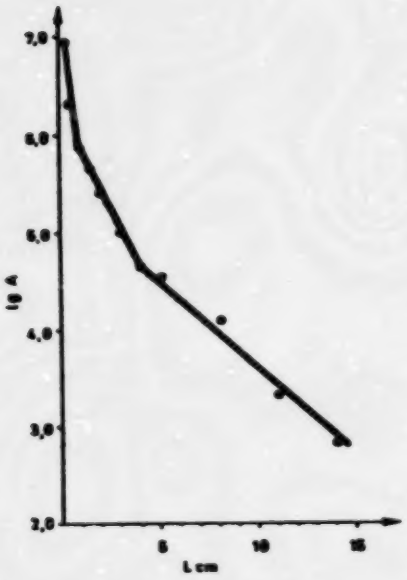

Figure 4.
Distribution of radioactive iodine in isotope exchange column at 150°C. Duration of experiment 180 h; velocity of gas 12 cm/s
L) distance from entrance to column (here and in Figure 5)
A) concentration of radioactive iodine, arbitrary units

Figure 5.
Distribution of radioactive iodine in isotope exchange columns with small- (curve 1) and large- (2) pore sorbent at 180°C and NO_2 content of ~5%; 10-h experiment; gas velocity 8 cm/s
A) concentration of iodine in arbitrary units

The high melting point of AgI makes it possible to work at rather high temperatures (up to 400°C) (Figure 6). In the temperature range of ~500°C appreciable evaporation of AgI is already observed.

In the presence of nitric oxides dissociation can occur, for example, through the following reaction:

$$2AgI + 2NO_2 + O \rightleftarrows 2AgNO_3 + I_2 \qquad (6)$$

The direction of the reaction is related to partial pressure of NO_2, O_2, I_2 and temperature. The reaction constant as a function of temperature was previously calculated on the basis of thermodynamic data. This reaction is the basis of operation of iodine columns with $AgNO_3$. According to these calculations, one must work at high temperatures to assure stability of AgI. The higher the partial pressure of nitrous oxides and oxygen and the lower the partial pressure of iodine fumes, the higher the working temperature of the column must be. Partial pressure of iodine is determined primarily by the stable isotope of iodine ^{127}I, which is contained in the gas phase.

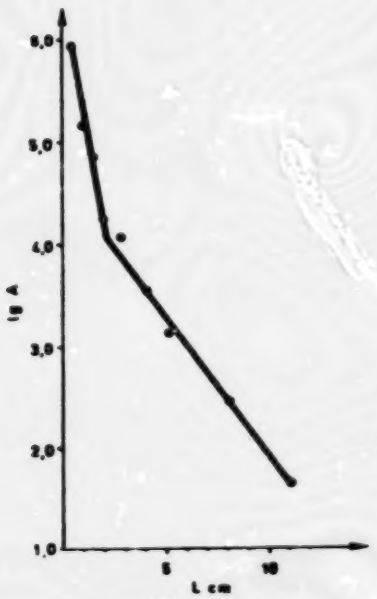

Figure 6.
Distribution of radioactive iodine in isotope exchange column at 400°C. Gas velocity 8 cm/s, time 164 h

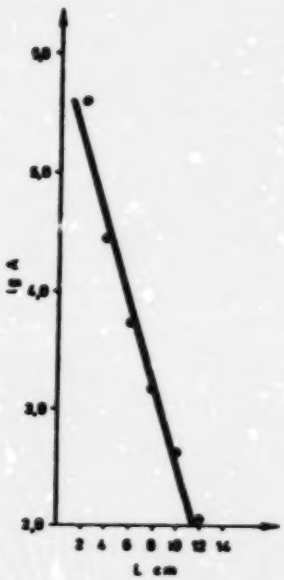

Figure 7.
Distribution of radioactive iodine in isotope exchange column in the presence of ~5% NO_2 at 200°C. Gas velocity 8 cm/s; time 40 h

L) distance from entrance to column
A) concentration of substance in arbitrary units

In actuality, the calculated reaction constants cannot be used for precise quantitative estimates, since $AgNO_3$ and AgI form solid solutions with one another. The partial thermodynamic potentials of solid solutions differ from the thermodynamic potentials of pure substances, and they are not known for the $AgI \cdot AgNO_3$ system. For this reason, the exact minimum required column temperatures as a function of composition of gas mixture cannot be calculated at the present time from the thermodynamic data, and they must be determined from experiments. Obviously, the working temperature must be set at a somewhat higher level than the minimum, in case of possible fluctuations in composition of the gas mixture.

Figure 7 illustrates the distribution of ^{131}I in the isotope exchange column after passage of a gas mixture containing air with addition of 5% NO_2 for 40 h. The logarithm of ^{131}I concentration in arbitrary units is plotted on the y-axis and distance from entrance to column on the x-axis. Column temperature is 200°C and velocity of gas flow 8 cm/s.

We have already mentioned the presence of chemical compounds of iodine in the gas phase, in particular ICN and certain others. The presence of salient points on the logC(x) curve (Figures 4 and 6) is indicative of presence of iodine compounds in the gas flow. Such points appear because function ϕ in equation (3) depends on the nature of the substances involved in isotope exchange and, consequently, different angles of inclination of log C(x) correspond to different substances. However, our findings indicate that radioactive iodine is extracted in isotope exchange columns not only from molecular iodine but from iodine compounds.

The question of term of continuous service of iodine columns merits discussion. Theoretically, "permanent" columns can function as long as desired, since entrance of iodine in the column is equilibrated by its radioactive decay in the solid phase. In practice, however, there may be side reactions that limit the term of column service. One of these reactions is the one with chlorine, which may be present as a trace [microimpurity] in nitric acid and pass from it into the gas phase. As a result, iodine is replaced with chlorine and there is formation of AgCl in the column.

The reaction constants:

$$2AgI + Cl_2 \rightleftharpoons 2AgCl + I_2 \qquad (7)$$

were calculated by us from the thermodynamic data, and they are listed in Table 2.

Table 2 shows that the reaction occurs, even with very low partial pressure of chlorine, lower by many orders of magnitude than the partial pressure of iodine.

Table 2. Constants of equilibrium of the reaction $2AgI + Cl_2 \rightleftarrows 2AgCl + I_2$

Temperature °C	25	100	200	250
K_e	$1,2 \cdot 10^{11}$	$7,5 \cdot 10^{8}$	$1,1 \cdot 10^{7}$	$5,3 \cdot 10^{6}$

Since the admixtures of chlorine are minimal in nitric acid, replacement ["ejection"] is very slow, and the column can function for several years.

2.2. In the case of gas mixtures containing no aggressive gases, activated charcoal is the most effective adsorbent for trapping iodine. Since quite a lot of information has already been published on adsorption of iodine in charcoal columns, we shall report only some data that supplement the published material. We submit below some data on equilibrated adsorption of iodine by active charcoal (see Table 3).

Table 3. Adsorption of gas from air at 20°C using activated charcoal No 3 (bulk specific gravity 0.5)

Relative humidity, %	Partial pressure of iodine fumes, torr	Adsorption index
Dry air	10^{-9}	$70 \cdot 10^{6}$
90%	10^{-9}	$14 \cdot 10^{6}$

The dimensionless coefficient [or index] of adsorption "Γ" was calculated using the following formula:

$$\Gamma = \frac{a}{c} \qquad (8)$$

where a is concentration of iodine in charcoal scaled to bulk volume of charcoal and c is concentration of iodine in the gas phase.

Charcoal No 3 does not have the best adsorption index among the existing charcoals. Higher coefficients of adsorption can be obtained with others. The method for determining the adsorption coefficients was selected in such a manner that presence of small amounts of iodine compounds could not affect substantially the results of measurements.

Adsorption equilibrium of iodine is established very slowly. Appreciable changes in equilibrium occurred within 80 h at 20°C. A comparison of the time of establishment of equilibrium at 20°C and 100°C shows that it is reached much faster at high temperatures. This suggests that activated diffusion of iodine in charcoal plays the decisive role, at least at the last stages of the process of establishment of equilibrium.

At low temperatures (-78°C or lower) there is virtually no establishment of adsorption equilibrium between the gas phase and activated charcoal, and we are then dealing with "frozen" nonequilibrated states. As a result of very slow internal diffusion, only the most accessible part of the surface is involved in adsorption. At low temperatures, the apparent coefficient of adsorption decreases with decrease in temperature.

The coefficients of adsorption of iodine are significantly lower on silica gel and zeolites than activated charcoal. For example, with 5 Å zeolite, the coefficient of adsorption is of the order of ~10^4; however, it is difficult to determine whether this is a real equilibrated value.

The results of experiments dealing with dynamic adsorption of radioactive iodine on activated charcoal were reported by us previously [19]. The theory of adsorption columns, in which dynamic sorption is combined with radioactive decay, was expounded in [18].

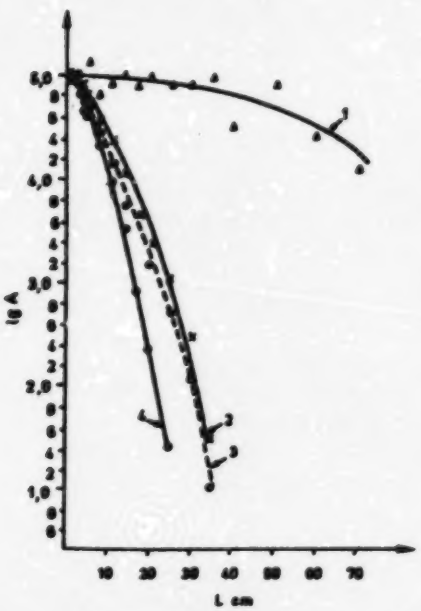

Figure 8.
Distribution of ^{131}I during passage of radioactive methyl iodide through column at 50°C with gas velocity of 30 cm/s; duration of experiment, 25 h
1) charcoal without impregnation
2) CuI-impregnated charcoal
3) PbI_2-impregnated charcoal
4) AgI-impregnated charcoal

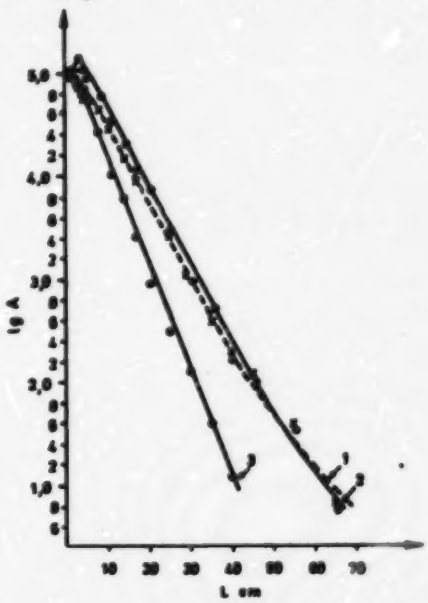

Figure 9.
Distribution of ^{131}I during passage of radioactive methyl iodide through column at 50°C; gas velocity 30 cm/s; time 232 h
1) AgI-impregnated charcoal
2) I_2-impregnated charcoal
3) PbI_2-impregnated charcoal

In both figures: L) distance from entrance to column
A) concentration of radioactive iodine

The data in the literature, as well as our experiments, indicate that methyl iodide and other alkyl iodides are present in air, along with molecular iodine. In charcoal columns, these compounds are sorbed only over a rather considerable length; however, it would be desirable to obtain higher purification coefficients with columns that are not overly long.

For this reason, we conducted experiments to test charcoals impregnated with various substances that undergo isotopic exchange with methyl iodide. In addition, these substances must be minimally soluble in water in order to assure operation of the columns after moisture gets into them.

These columns are analogous to the above-described isotope exchange columns with respect to principle of operation. Figures 8 and 9 illustrate the results of experiments with charcoal No 4 impregnated with AgI, PbI_2, CuI, I_2, as well as nonimpregnated charcoal. A mixture of air and radioactive methyl iodide was passed through columns, each of which was equipped with one of the above charcoals. The distribution of concentrations in the columns indicates that the coefficients of purification of methyl iodide are higher by several orders of magnitude for impregnated charcoal than nonimpregnated and, consequently, the effects of purification observed in the columns are related to isotopic exchange between metal iodides and methyl iodide.

In analogous experiments, high purification coefficients persisted at 50°C and partial pressure of water vapor of ~15 torr. Long-term experiments with columns of impregnated charcoal were conducted to establish stationary distribution of concentrations of radioactive iodine in the columns. The experiments lasted 32 days, with overnight breaks. Total work time was 232 h. Figure 9 illustrates the results of these experiments. All of the columns yielded high purification indices. Activity was somewhat lower in the first section of the column impregnated with molecular iodine than in the second. This should probably be attributed to desorption of I_2 from charcoal, which began under the influence of air. The column with PbI_2 behaved somewhat better than the others.

In practice, one has to extract radioactive iodine from gas mixtures, in which methyl iodide constitutes a minor addition to molecular iodine. As a result of poor adsorption of methyl iodide, this addition limits the possibilities of obtaining high purification coefficients. Isotopic exchange of methyl iodide on impregnated charcoal removes this limitation.

In the literature there have already been reports of impregnation of charcoal with potassium iodide and molecular iodine; however, in a number of cases, application on charcoal of compounds that are not soluble in water, such as PbI_2, AgI and CuI, will have advantages.

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RADIOACTIVITY OF OCEAN WATERS AND THE BEHAVIOR OF CERTAIN FISSION PRODUCTS IN THE OCEAN

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[Text] All uses of atomic energy cause contamination of the environment by one or another radioactive products, for the greater part of which the ocean is the ultimate reservoir. The strontium-90 and cesium-137 content in regions of greatest importance in this regard were determined over the period of 1965-1970 to provide the current characteristics of artificial radioactivity in the oceans. The mean strontium-90 and cesium-137 concentration in the surface water was found for each investigated region and its minimum and maximum values were also determined. Data were also obtained on time variation of the concentration. It decreased in the Pacific Ocean and remained at an approximately constant level in the Atlantic Ocean during the period 1965-1970, usually comprising from 15 to 50 disintegrations per minute per 100 liters at latitudes of 70°N and from 30 to 150 disintegrations per minute per 100 liters at latitudes of 40°N. Resorption of previously observed areas of high concentration of radioactivity in the Pacific Ocean was investigated. Locations with increased radioactive contamination were clearly shown to be the result of radioactive waste disposal. Deep-sea samples were taken from the oceans and the strontium-90 and cesium-137 content in the water was estimated. Approximate agreement of this estimate with data from observations of radioactive fallout was noted. Deep currents of water with increased strontium-90 concentration entering the ocean due to waste disposal were found. The behavior of cerium, yttrium and niobium isotopes in the ocean was

studied. The specific effect of sea water on the state of radionuclides was established. Specifically, yttrium-91 is subjected to a significant effect of natural ligands and is in the truly dissolved state in the thermal barrier; approximately 60 percent of the element goes into suspension in other water samples. The biogenic and abiogenic processes of extracting radionuclides from sea water were considered. Abiogenic uptake and fixing of radionuclides by suspension depends on the properties of the substance suspended in the ocean. It is shown that iron, as a biogenic element, contributes to introduction of cerium-144, yttrium-91 and niobium-95 into plankton organisms, that is, into the active biological cycle. The absorption of these nuclides by bottom sediments from sea water in the Indian and Pacific Oceans was studied.

Radioactive waste disposal in the water environment is becoming more massive in nature in the modern world. The role of this process in radioactive contamination of the ocean has become comparable in some locations to the role of global radioactive fallout. The bibliography on radioactive contamination of the ocean is rather fully represented in [1, 2]. Among new publications, [3] and [4] are especially interesting. The latest results of investigations, the previous stages of which were described previously [5, 7], are outlined in this report.

Global radioactive contamination of the ocean was studied mainly from data of observing the concentration of long-lived radionuclides: Sr-90 and Cs-137 [8, 9]. The results of our recent measurements are presented. The behavior of shorter-lived isotopes, including Ce-144, Y-91, Nb-95 and Mo-99 (Tc-99), must be known when studying radioactive contamination occurring due to radioactive waste disposal. The results of the first stages of studying the behavior of these radionuclides in sea water are reported below.

The Sr-90 and Cs-137 content in surface waters at 92 locations of the Pacific Ocean at the end of 1966 and the beginning of 1967 and also at some points of the Atlantic Ocean in 1967 is presented in Table 1. All the data of Table 1 are shown on the charts of Figure 1 and Figure 2. The distribution profiles of Sr-90 and Cs-137 by depth are presented in Table 2. Reliable results were found at all the investigated locations to a depth of 500 meters. The concentration was frequently below the sensitivity of the method at greater depths. Nevertheless, locations were found where the Sr-90 and Cs-137 concentration, even at a depth of 1,000 m and sometimes greater, was above the limit of sensitivity and was determined with sufficient reliability.

The Sr-90 and Cs-137 content in the layer of water to a depth of 500 meters and at some locations to a depth of 1,000 meters was estimated at many points from data on the depth distribution of the concentration. The

results are presented in Table 3. The derived estimate of the content is shown on the chart on Figure 3 and Figure 4. Some characteristics of radioactive contamination of waters by individual regions of the oceans are noted.

The Sr-90 concentration was 71 disintegrations per minute per 100 liters of water in November 1966 and the Cs-137 concentration was 79 disintegrations per minute per 100 liters at one point in the Sea of Japan. Comparison of the figures to data for the Mediterranean and Black Seas [5, 6] shows that the concentration of these radionuclides is higher in all closed seas than in the open ocean at the same latitude. Global radioactive fallout from 1962 through 1966 decreased [10], but the Sr-90 and Cs-137 concentration in these seas hardly diminished. The Sr-90 and Cs-137 content in the layer of water from the surface to a depth of 500 meters in the Sea of Japan was 95 and 107 millicuries per square kilometer and that to a depth of 1,000 meters was 135 and 162 millicuries per square kilometer, respectively. According to data of the United Nations Scientific Committee on the Effects of Atomic Radiation, found from observations on land stations, one should expect 60-80 millicuries per square centimeter of Sr-90 in this region [11]. Excess Sr-90 is present.

The waters of the northwestern Pacific Ocean were contaminated due to nuclear arms testing in the Marshall Islands. A region of extreme radioactive contamination was observed here in 1954 and 1955. The position was quite different in the fall of 1966. The results were compared to data of past years [12, 13] in Figure 5, in which data for the Atlantic are also presented [5, 6]. The Sr-90 content in the surface water of this region decreased significantly during recent years and comprised an average of 30 disintegrations per minute per 100 liters in the fall of 1966. The Cs-137 concentration was an average of 49 disintegrations per minute per 100 liters. The zone of increased concentration in the region of Bikini-Eniwetok had essentially disappeared. The Sr-90 and Cs-137 content in the upper 500 meters of water no longer differed from that in other regions of the northwestern Pacific Ocean. True, the upper layer of 1,000 meters contains 115 millicuries per square kilometer of Cs-137 over the Marianis Trench. The concentration in the Marianis Trench at great depths is below the range of sensitivity. Samples were taken here to a depth of 8,000 meters.

The Sr-90 and Cs-137 concentration in the southwestern Pacific Ocean was less in the surface waters than in the northwestern part. Comparison of the average figures is given in Table 4. Data for the Atlantic Ocean are also presented in this table [6]. The ratio was maintained from year to year. Detectable amounts of Sr-90 and Cs-137 existed only in the upper layer of the water above the deepwater Kermadec Trench. Deep waters to 9,000 meters were pure, although they were not quite stagnant according to preliminary hydrological data [16] and may be supplemented due to dropping of the water mass in other regions.

Table 2. Sr-90 and Cs-137 Content in the Surface Water of the Oceans

(1) Дата отбора пробы	(2) Координаты места отбора пробы: широта	долгота	(5) Концентрация расп./мин·100 л: ^{90}Sr	^{137}Cs	(6) Отнош. $^{137}Cs/^{90}Sr$
	(3)	(4)	Тихий океан (7)		
1966					
1.11	42°10°С	134°32°В	71 ± 11	79 ± 11	1,1
8.11	40°00°С	142°10°В	44 ± 7	66 ± 9	1,5
8.11	36°00°С	142°41°В	46 ± 7	70 ± 11	1,5
8.11	30°00°С	144°07°В	43 ± 7	36 ± 10	1,0
9.11	26°10°С	146°17°В	36 ± 5	70 ± 8	1,9
10.11	22°30°С	148°48°В	43 ± 6	81 ± 11	1,8
11.11	18°30°С	149°28°В	40 ± 7	86 ± 10	1,1
13.11	13°00°С	147°00°В	43 ± 7	58 ± 7	1,3
14.11	13°40°С	146°40°В	16 ± 3	33 ± 3	1,8
15.11	13°22°С	145°24°В	23 ± 4	44 ± 6	1,9
16.11	12°50°С	144°41°В	21 ± 3	41 ± 6	1,9
17.11	12°30°С	144°23°В	22 ± 4	42 ± 6	1,9
18.11	11°42°С	141°30°В	22 ± 4	38 ± 5	1,7
19.11	12°00°С	140°10°В	30 ± 5	56 ± 10	1,8
20.11	12°00°С	138°40°В	31 ± 3	60 ± 9	1,9
21.11	12°01°С	137°13°В	14 ± 3	26 ± 6	1,7
22.11	10°23°С	136°55°В	10 ± 2	18 ± 5	1,8
23.11	8°20°С	171°10°В	10 ± 3	21 ± 9	1,6
24.11	6°43°С	168°40°В	30 ± 6	42 ± 11	1,1
25.11	6°00°С	167°11°В	21 ± 5	38 ± 14	1,8
26.11	3°25°Ю	166°00°В	20 ± 3	37 ± 11	1,9
27.11	1°00°Ю	165°40°В	27 ± 4	32 ± 11	1,2
28.11	15°20°Ю	165°45°В	9 ± 2	16	-
29.11	16°51°Ю	167°30°В	11 ± 2	11 ± 2	1,0
1.12	21°10°Ю	167°32°В	12 ± 2	21 ± 6	1,7
2.12	25°10°Ю	167°10°В	10 ± 2	-	-
3.12	28°05°Ю	164°40°З	17 ± 3	30 ± 9	1,8
4.12	32°52°Ю	162°30°В	23 ± 4	32 ± 13	1,4
5.12	36°52°Ю	162°30°В	26 ± 4	30 ± 12	1,1
10.12	36°46°Ю	163°22°В	27 ± 4	37 ± 10	1,4
11.12	33°20°Ю	160°30°В	11 ± 2	15 ± 7	1,3
12.12	33°01°Ю	160°04°В	10 ± 2	16 ± 7	1,6
13.12	32°41°Ю	160°10°В	8 ± 2	-	-
14.12	32°30°Ю	174°50°В	8 ± 2	-	-
15.12	32°09°Ю	178°10°В	10 ± 2	-	-
16.12	32°02°С	177°30°З	9 ± 2	-	-
16.12	32°02°Ю	177°30°З	11 ± 2	10	-
18.12	30°42°Ю	176°00°З	8 ± 2	10 ± 7	1,7
19.12	29°07°Ю	174°30°З	8 ± 2	10	-
21.12	26°12°Ю	173°10°З	20 ± 6	-	-
22.12	25°30°Ю	169°00°З	26 ± 8	-	-
23.12	24°47°Ю	168°24°З	130 ± 20	-	-
26.12	17°07°Ю	163°05°З	26 ± 4	26 ± 9	1,0
27.12	17°30°Ю	162°40°З	19 ± 3	-	-
30.12	16°03°Ю	160°48°З	21 ± 5	-	-
30.12	16°43°Ю	160°04°З	13 ± 2	22 ± 8	1,7
31.12	16°28°Ю	160°28°З	10 ± 2	17 ± 7	1,7
1967					
1.01	20°14°Ю	160°24°З	12 ± 2	16 ± 9	1,3
2.01	18°08°Ю	158°27°З	13 ± 2	15 ± 8	1,1
4.01	16°08°Ю	157°30°З	9 ± 2	16 ± 6	1,7
5.01	11°40°Ю	156°42°З	7 ± 1	13 ± 7	1,9
6.01	9°46°Ю	156°28°З	10 ± 2	-	-
7.01	8°41°Ю	156°42°З	8 ± 1	-	-
8.01	1°12°Ю	156°06°З	9 ± 2	-	-
9.01	0°34°С	156°38°З	10 ± 2	-	-
10.01	4°20°С	155°18°З	10 ± 2	-	-
11.01	8°01°С	156°01°З	12 ± 2	-	-
12.01	13°16°С	151°04°З	17 ± 3	-	-
13.01	18°53°С	150°20°З	17 ± 3	-	-
14.01	20°10°С	150°04°З	24 ± 4	-	-
15.01	23°41°С	127°42°З	34 ± 5	-	-
16.01	28°00°С	126°20°З	63 ± 10	-	-
17.01	32°10°С	125°13°З	85 ± 10	-	-
24.01	36°21°С	125°01°З	20 ± 6	-	-
25.01	41°18°С	126°30°З	78 ± 20	-	-
26.01	43°52°С	127°50°З	26 ± 10	100 ± 12	3,8
26.01	41°10°С	126°00°З	96 ± 16	110 ± 12	1,1
26.01	44°21°С	125°21°З	90 ± 14	123 ± 14	1,3
27.01	46°13°С	125°07°З	86 ± 10	110 ± 12	1,3
27.01	45°28°С	126°51°З	84 ± 16	90 ± 10	1,0
27.01	46°14°С	126°43°З	89 ± 16	89 ± 10	1,0
28.01	46°28°С	126°30°З	86 ± 8	76 ± 10	1,0
28.01	46°52°С	126°20°З	49 ± 7	73 ± 10	1,5
29.01	46°41°С	125°45°З	88 ± 16	102 ± 12	1,2
29.01	46°28°С	126°26°З	79 ± 11	107 ± 12	1,4
29.01	46°37°С	126°06°З	80 ± 8	100 ± 11	2,0
29.01	46°20°С	126°02°З	81 ± 7	90 ± 12	1,7
30.01	43°10°С	126°10°З	62 ± 9	108 ± 13	1,7
31.01	38°10°С	125°50°З	38 ± 6	-	-
1.02	36°07°С	125°43°З	62 ± 9	84 ± 9	1,0
2.02	31°14°С	126°18°З	46 ± 7	-	-
3.02	28°00°С	116°48°З	87 ± 9	110 ± 13	2,0
4.02	28°01°С	113°31°З	47 ± 7	-	-
5.02	23°12°С	110°18°З	30 ± 6	-	-
6.02	20°33°С	107°41°З	31 ± 5	-	-
7.02	18°19°С	103°00°З	16 ± 3	-	-
8.02	16°31°С	98°20°З	25 ± 4	-	-

[Table continued on following page]

Table 1 (Continued).

Дата отбора проб	Координаты места отбора проб		^{90}Sr расп/мин на 100 л
	широта	долгота	
Тихий океан			
9.08	14°18'С	98°08'З	14 ± 2
10.08	12°12'С	98°10'З	16 ± 2
11.08	10°30'С	98°08'З	18 ± 2
12.08	8°08'С	98°14'З	18 ± 2
13.08	6°30'С	91°47'З	14 ± 2
Атлантический океан			
1957			
16.01	11°34'С	76°18'З	9 ± 2
17.01	14°28'С	68°38'З	14 ± 2
18.01	15°04'С	68°18'З	21 ± 3
19.01	16°08'С	68°08'З	8 ± 1
20.01	18°04'С	64°08'З	7 ± 1
21.01	20°17'С	61°23'З	16 ± 2
22.01	21°17'С	60°08'З	20 ± 3
23.01	22°08'С	60°38'З	9 ± 2
24.01	23°12'С	60°41'З	9 ± 1
25.01	24°08'С	60°38'З	9 ± 1
26.01	24°38'С	64°18'З	10 ± 2
27.01	24°34'С	65°40'З	17 ± 3
28.01	23°40'С	70°40'З	8 ± 1
29.01	23°38'С	70°40'З	17 ± 3

Дата отбора проб	Координаты места отбора проб		^{90}Sr расп/мин на 100 л
	широта	долгота	
(8) Атлантический океан			
10.08	26°04'С	76°31'З	22 ± 4
11.08	25°38'С	76°40'З	10 ± 3
12.08	25°58'С	77°08'З	18 ± 2
13.08	25°42'С	73°37'З	7 ± 1
14.08	25°17'С	69°08'З	6 ± 1
15.08	24°38'С	65°08'З	8 ± 1
16.08	22°38'С	61°40'З	22 ± 3
17.08	20°38'С	57°18'З	21 ± 3
18.08	17°38'С	52°04'З	8 ± 1
19.08	14°08'С	52°14'З	4 ± 1
20.08	11°18'С	52°18'З	5 ± 1
21.08	8°07'С	48°17'З	14 ± 2
22.08	5°04'С	48°18'З	17 ± 3
23.08	1°08'С	41°38'З	11 ± 2
24.08	0°38'С	37°38'З	3 ± 1
25.08	1°34'С	34°08'З	21 ± 3
26.08	0°07'С	34°38'З	18 ± 2
27.08	4°38'С	34°38'З	7 ± 1
28.08	8°08'С	34°38'З	16 ± 2
29.08	12°38'С	34°38'З	16 ± 2
30.08	16°38'С	33°37'З	8 ± 1
31.08	19°04'С	33°38'З	8 ± 1

Дата отбора проб	Координаты места отбора проб		^{90}Sr расп/мин на 100 л
	широта	долгота	
Атлантический океан			
11.09	22°18'С	41°48'З	18 ± 2
12.09	22°38'С	41°18'З	8 ± 1
13.09	19°38'С	38°41'З	8 ± 2
14.09	16°38'С	38°08'З	6 ± 1
15.09	14°38'С	16°38'З	6 ± 1
16.09	9°38'С	16°37'З	7 ± 1
17.09	4°48'С	11°37'З	8 ± 1
18.09	2°38'С	8°38'З	7 ± 1
19.09	0°07'С	4°08'З	8 ± 1
20.09	00°00'	00°00'	8 ± 1
21.09	2°18'С	4°48'З	3 ± 1
22.09	6°48'С	12°08'З	8 ± 2
23.09	8°48'С	16°38'З	11 ± 2
24.09	12°18'С	17°38'З	8 ± 1
25.09	21°38'С	17°38'З	3 ± 1
26.09	26°34'С	11°38'З	16 ± 3
27.09	26°34'С	11°38'З	10 ± 2
28.09	26°34'С	11°38'З	8 ± 1
29.09	26°18'С	9°38'З	8 ± 1
30.09	42°48'С	6°38'З	8 ± 1
31.09	48°48'С	8°18'З	3 ± 1
32.09	54°38'С	28°38'З	22 ± 4

Key:

1. Date of taking sample
2. Coordinates of taking sample
3. Latitude
4. Longitude
5. Concentration, disintegrations per minute per 100 liters
6. Ratio
7. Pacific Ocean
8. Atlantic Ocean

Table 2. Sr-90 and Cs-137 Content in the Deep Waters of the Oceans

(1) Дата отбора пробы	(2) Координаты	(3) Глубина океана м	(4) Глубина горизонта отбора пробы м	(5) Концентрация мкюри/литр: ^{90}Sr	(5) Концентрация мкюри/литр: 100 ^{137}Cs	(6) Отношение $^{137}Cs/^{90}Sr$
(7) Тихий океан						
1966						
1.11	43°13'С 134°32'З	3700	0	71 ± 11	79 ± 11	1,1
			200	46 ± 6	65 ± 8	1,3
			500	26 ± 5	27 ± 7	1,0
			1000	7 ± 3	10 ± 5	1,4
8.11	50°09'С 142°41'В	6413	0	46 ± 7	70 ± 11	1,5
			500	14 ± 3	-	-
			1000	8 ± 2	10	-
			3000	5	10	-
10.11	25°30'С 148°48'В	7073	0	43 ± 7	81 ± 11	1,8
			500	19 ± 3	27 ± 10	1,4
			1000	19 ± 3	21 ± 8	1,1
			3000	8 ± 1	11 ± 6	1,3
			7000	10 ± 2	17 ± 8	1,7
11.11	19°30'С 161°25'В	6650	0	49 ± 7	55 ± 10	1,1
			200	27 ± 6	40 ± 8	1,5
			500	11 ± 2	10	-
			1000	11 ± 2	10	-
			2000	5	10	-
			3000	5	-	-
			6000	5	10	-
13.11	13°00'С 167°00'В	5300	0	43 ± 7	66 ± 7	1,5
			100	20 ± 4	66 ± 8	1,7
			200	18 ± 4	21 ± 8	1,1
			500	9 ± 2	10	-
			1000	-	-	-
			5000	5	10	-
16.11	11°42'С 161°30'В	1940	0	22 ± 4	42 ± 6	1,9
			100	22 ± 4	30 ± 5	1,3
			5000	10 ± 2	-	-
			9000	7 ± 2	-	-

Дата отбора пробы	Координаты	Глубина океана м	Глубина горизонта отбора пробы м	Концентрация мкюри/литр: ^{90}Sr	Концентрация мкюри/литр: 100 ^{137}Cs	Отношение $^{137}Cs/^{90}Sr$
Тихий океан						
19.12			2000	5 ± 2	10	-
			3000	5 ± 2	10	-
			5300	5	10	-
			8000	5	10	-
21.12	30°13'Ю 172°10'З	9527	0	30 ± 5	-	-
			500	16 ± 3	-	-
			1000	5	10	-
			2000	5 ± 2	-	-
			3000	5	10	-
			4000	5	10	-
			8000	5	10	-
28.12	17°07'Ю 168°03'З	4313	0	26 ± 4	26 ± 9	1,0
			750	18 ± 3	19 ± 4	1,0
			2000	16 ± 3	20 ± 9	1,1
30.12	10°43'Ю 160°04'З	4554	0	13 ± 2	22 ± 8	1,7
			500	10 ± 2	15 ± 8	1,5
31.12	10°28'Ю 142°32'З	4616	0	10 ± 2	17 ± 7	1,7
			500	5	10	-
			1000	5	10	-
			2000	5	-	-
			3000	5	10	-
1967						
1.01	20°16'Ю 169°24'З	4585	0	12 ± 2	18 ± 9	1,5
			500	5	10	-
			1000	5	10	-
			2000	5	10	-
			4000	5	10	-
2.01	10°00'Ю 138°27'З	5007	0	13 ± 2	15 ± 8	1,1
			300	7 ± 2	12 ± 6	1,7
			500	7 ± 2	-	-
			1000	5	10	-
			2000	-	-	-

[Table continued on following page]

Table 2 (Continued).

– 19.11	12°06'C 162°10'E	2880	0 500 1000 2000	30 ± 6 15 ± 3 11 ± 3 17 ± 3	46 ± 14 20 ± 7 14 ± 6 29 ± 9	1,8 1,3 1,3 1,7
20.11	15°05'C 164°46'E	1807	0 200 500 1000 2000	21° ± 3 9 ± 2 9 ± 2 6 ± 2 5 ± 3	40 ± 9 18 ± 7 17 ± 5 10 ± 5 10	1,0 1,8 1,9 1,8 -
8.11	0°09'C 167°11'E	4388	0 500 1000 2000 4000	31 ± 8 11 ± 5 7 ± 3 5 5	38 ± 14 17 ± 8 12 ± 6 10 10	1,2 1,8 1,7 - -
30.11	13°30'N 150°42'E	2686	0 500 1000	9 ± 2 5 ± 3 6 ± 2	10 10 10	- - -
2.12	20°10'N 157°10'E	3750	0 500 1000 2000	10 ± 2 10 ± 2 12 ± 3 5 ± 2	- 15 ± 3 13 ± 6 10	- 1,8 1,8 -
12.12	20°01'N 160°04'E	5131	0 500 1000 2000	10 ± 2 5 ± 2 5 5	16 ± 7 - - -	1,8 - - -
16.12	20°03'N 177°30'E	10000	0 200 1000	11 ± 2 7 ± 2 5 ± 2	10 10 10	- - -
16.12	20°03'N 177°30'E	10000	2000 4700 9000	5 5 ± 2 5	10 10 10	- - -
18.12	15°42'N 176°09'E	5587	0 500 7000	9 ± 2 5 5	16 ± 7 10 10	1,7 - -
18.12	22°07'N 174°30'E	10141	0 500 1000	9 ± 2 7 ± 3 6 ± 3	10 - 10	- - -
4.01	16°05'N 137°30'E	4039	0 500 1000 2000 3000	9 ± 2 5 5 5 5	16 ± 6 - 10 10 10	1,7 - - - -
5.01	11°48'N 138°43'E	4170	0 500 1000 2000 3000	7 ± 1 5 5 5 5	12 ± 7 10 10 10 10	1,8 - - - -
8.01	1°12'N 134°30'E	4183	0 500	9 ± 2 5 ± 2	- -	- -
18.01	13°14'C 131°04'E	5507	0 500 1000 2000	17 ± 1 5 5 5	- 10 - 10	- - - -
25.01	42°22'C	2936	0 500 1000	126 ± 18 111 ± 17 81 ± 2	100 ± 13 45 ± 16 -	0,8 0,4 -
26.01	44°10'C 128°00'E	2941	0 500 1000	106 ± 18 68 ± 10 17 ± 2	119 ± 12 - 30 ± 10	1,1 - 1,8
26.01	44°27'C 128°27'E	2931	0 500 1000	90 ± 13 58 ± 6 40 ± 6	123 ± 14 - 30 ± 12	1,3 - 0,6
27.01	45°13'C 129°01'E	1607	0 500 1000	68 ± 10 18 ± 3 8 ± 1	110 ± 12 18 ± 8 14 ± 7	1,6 1,0 1,7
27.01	45°22'C 126°51'E	981	0 500	64 ± 10 6 ± 2	98 ± 10 10	1,6 -
27.01	46°14'C 126°43'E	780	0 200	69 ± 9 41 ± 7	89 ± 10 23 ± 7	1,3 0,6
28.01	46°36'C 126°36'E	883	0 500	56 ± 8 19 ± 3	76 ± 16 10	1,4 -
28.01	46°58'C 126°46'E	170	0 100	45 ± 7 38 ± 5	72 ± 10 68 ± 10	1,6 1,8

[Table continued on following page]

Table 2 (Continued).

Дата отбора пробы	Координаты	Глубина океана м	Глубина горизонта отбора пробы	Концентрация расп/мин. 100 л ^{90}Sr	Концентрация расп/мин. 100 л ^{137}Cs	Отношение $^{137}Cs/^{90}Sr$
Тихий океан						
29.01	48°32'С 138°29'З	2670	0	78±11	107±12	1,4
			500	5±1	-	-
			1000	5±1	10	-
5.02	35°13'С 110°10'З	3000	0	30±6	-	-
			500	5	-	-
			1000	5	-	-
			2000	5	-	-
Атлантический океан (8)						
1967						
10.02	11°24'С 80°10'З	3000	0	9±1	-	-
			500	2±1	-	-
			1000	1±1	-	-
			2000	1±1	-	-
20.02	21°48'С 60°10'З	1400	0	11±2	-	-
			200	7±1	-	-
			500	10±2	-	-
			800	3±1	-	-
02.03	25°00'С 50°50'З	3000	0	9±1	-	-
			500	7±1	-	-
			1000	10±2	-	-
			2000	1±1	-	-
			3000	3±1	-	-
03.03	27°13'С 68°41'З	2000	0	3±1	-	-
			500	3±1	-	-
			1000	4±1	-	-
04.03	28°00'С 66°50'З	3100	0	3±1	-	-
			500	16±3	-	-
			1000	8±1	-	-
			1850	27±4	-	-
08.03	27°50'С 70°43'З	430	0	17±3	-	-
			100	5±1	-	-
			200	4±1	-	-
			300	2±1	-	-
10.03	28°04'С 70°31'З	730	0	22±4	-	-
			200	21±3	-	-
			500	16±3	-	-
			700	1±1	-	-
11.03	28°30'С 70°45'З	700	0	10±3	-	-
			300	1±1	-	-
12.03	28°50'С 71°58'З	800	0	12±3	-	-
			700	3±1	-	-

Дата отбора пробы	Координаты	Глубина океана м	Глубина горизонта отбора пробы	Концентрация расп/мин. 100 л ^{90}Sr	Концентрация расп/мин. 100 л ^{137}Cs	Отношение $^{137}Cs/^{90}Sr$
Атлантический океан						
17.03	24°30'С 68°09'З	5500	0	5±1	-	-
			500	4±1	-	-
22.03	14°00'С 62°14'З	4800	0	4±1	-	-
			500	1±1	-	-
			1000	8±1	-	-
			4000	2±1	-	-
27.03	1°00'С 41°30'З	4300	0	11±2	-	-
			500	3±1	-	-
			1000	1±1	-	-
			3000	1±1	-	-
03.04	0°20'Ю 37°20'З	4500	0	3±1	-	-
			500	1±1	-	-
			1000	1±1	-	-
			3000	3±1	-	-
			2500	3±1	-	-
03.04	1°31'С 34°50'З	4000	0	21±3	-	-
			500	6±1	-	-
			1000	4±1	-	-
			2000	2±1	-	-
04.04	0°27'С 34°29'З	4000	0	12±2	-	-
			500	5±1	-	-
			500	8±1	-	-
			1000	4±1	-	-
			3200	1±1	-	-
11.04	35°10'Ю 41°48'З	3600	0	10±2	-	-
			500	36±6	-	-
			1000	4±1	-	-
20.04	0°07'С 4°48'З	5170	0	5±1	-	-
			500	8±1	-	-
			3000	1±1	-	-
			3400	7±1	-	-
08.06	15°18'С 17°38'З	800	0	6±1	-	-
			200	3±1	-	-
			500	5±1	-	-
10.06	42°48'С 4°33'В	1200	0	8±1	-	-
			500	1±1	-	-
			1000	1±1	-	-
10.06	42°45'С 8°14'В	1300	0	3±1	-	-
			500	2±1	-	-
			1000	1±1	-	-

Key:

1. Date of taking sample
2. Coordinates
3. Depth of ocean, meters
4. Depth of sampling level
5. Concentration, disintegrations per minute per 100 liters
6. Ratio
7. Pacific Ocean
8. Atlantic Ocean

Table 3. Sr-90 and Cs-137 Content at Individual Points of the Pacific and Atlantic Oceans in the Water Layer From the Surface to a Depth of 1,000 m

Дата разреза (1)	Координаты разреза (2)		Запас мКи/км² в слое от поверхности до глубины (5)			
			500 м		1000 м	
	широта (3)	долгота (4)	^{90}Sr	^{137}Cs	^{90}Sr	^{137}Cs
		Тихий океан (6)				
1966						
1.11	42°19' С	134°32' В	96	117	136	162
8.11	38°09' С	143°41' В	70	-	95	-
10.11	33°30' С	145°48' В	70	130	110	180
11.11	29°30' С	147°29' ВД	73	-	90	-
13.11	25°00' С	147°00' В	50	-	-	-
16.11	21°45' С	151°30' В	43	-	63	-
19.11	15°00' С	152°10' В	55	65	85	125
20.11	12°00' С	154°40' В	35	50	45	80
22.11	9°00' С	157°15' В	50	65	70	100
28.11	13°30' Ю	155°45' В	15	-	30	-
3.12	20°10' Ю	157°15' В	25	-	50	-
12.12	35°00' Ю	160°00' В	30	-	-	-
16.12	38°00' Ю	177°30' З	-	-	32	-
19.12	35°57' Ю	176°30' З	30	-	35	-
21.12	30°15' Ю	172°10' З	50	-	-	-
30.12	18°45' Ю	166°50' З	30	45	-	-
1967						
3.01	10°50' Ю	159°27' З	10	-	-	-
5.01	01°15' Ю	156°00' З	15	-	-	-
30.01	43°50' С	167°00' З	270	105	450	-
30.01	44°10' С	160°00' З	160	-	290	350
30.01	44°30' С	152°30' З	160	-	270	340
27.01	48°12' С	129°07' З	90	140	130	180
27.01	48°32' С	136°01' З	80	-	-	-
27.01	48°14' С	136°43' З	94	77	-	-
28.01	46°30' С	134°30' З	85	-	-	-
28.01	46°41' С	128°48' З	90	125	110	-
29.01	46°32' С	130°30' З	80	-	100	-
1967		Атлантический океан (7)				
16.01	11°34' С	50°10' З	10	-	-	-
20.01	21°48' С	56°10' З	20	-	-	-
3.02	25°00' С	50°30' З	10	-	22	-
4.02	26°00' С	54°30' З	21	-	40	-
10.02	28°04' С	79°31' З	44	-	-	-
12.02	29°50' С	77°50' З	34	-	-	-
17.02	34°30' С	69°00' З	10	-	-	-
22.02	14°00' С	58°14' З	8,8	-	17	-
27.02	1°00' С	41°50' З	10	-	-	-
3.03	0°10' Ю	37°30' З	4,5	-	-	-
5.03	1°30' С	34°50' З	30	-	41	-
6.03	0°27' С	34°30' З	31	-	27	-
11.03	20°10' С	61°45' З	60	-	100	-
20.03	5°07' С	4°45' З	15	-	-	-
5.04	12°10' С	17°30' З	10	-	-	-

Key:

1. Date of profile
2. Coordinates of profile
3. Latitude
4. Longitude
5. Content, millicuries per square kilometer in the layer from the surface to a depth of
6. Pacific Ocean
7. Atlantic Ocean

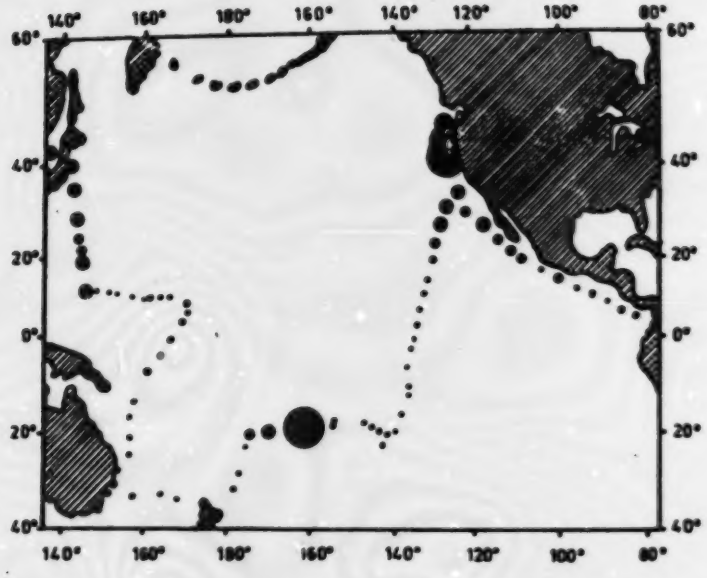

Figure 1. Sr-90 Concentration in the Surface Waters of the Pacific Ocean During 1966-1967 (the diameter of the circles is proportional to the extent of concentration)

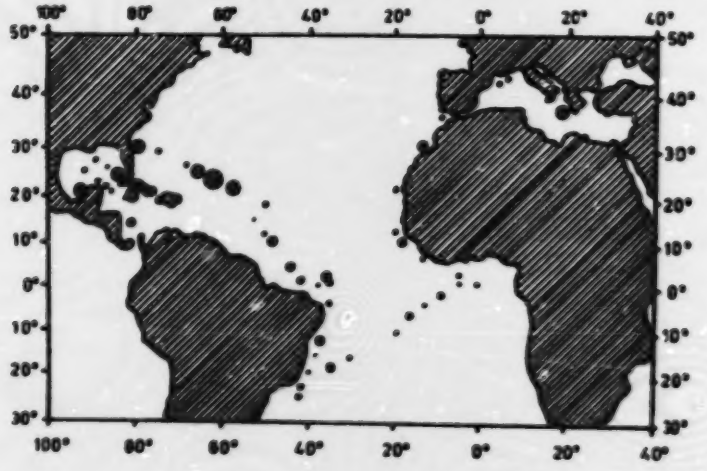

Figure 2. Sr-90 Concentration in the Surface Waters of the Atlantic Ocean in 1967 (the diameter of the circles is proportional to the extent of concentration)

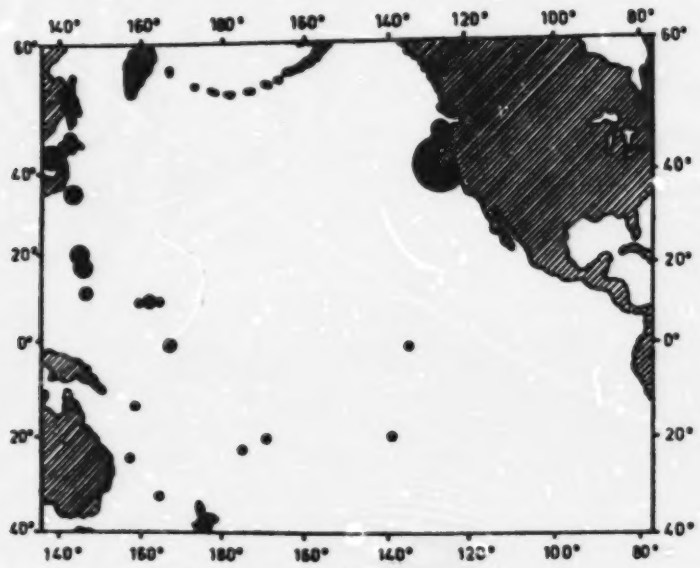

Figure 3. Sr-90 Content in Layer of Water to 500 Meters Per Unit Area of the Pacific Ocean Basin

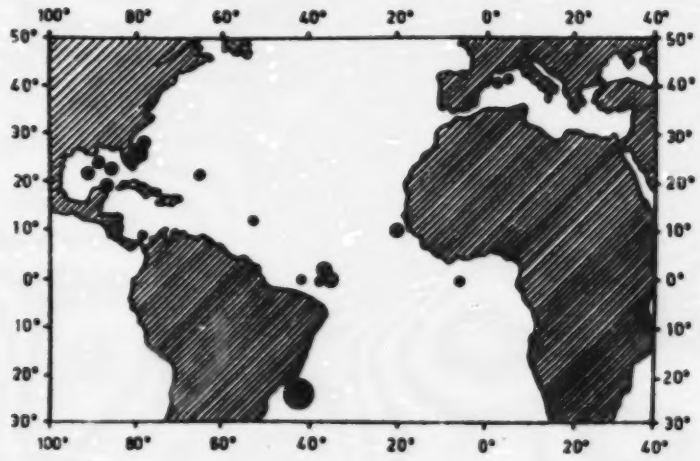

Figure 4. Sr-90 Content in the Water Layer to 500 Meters Per Unit Area of the Atlantic Ocean Basin

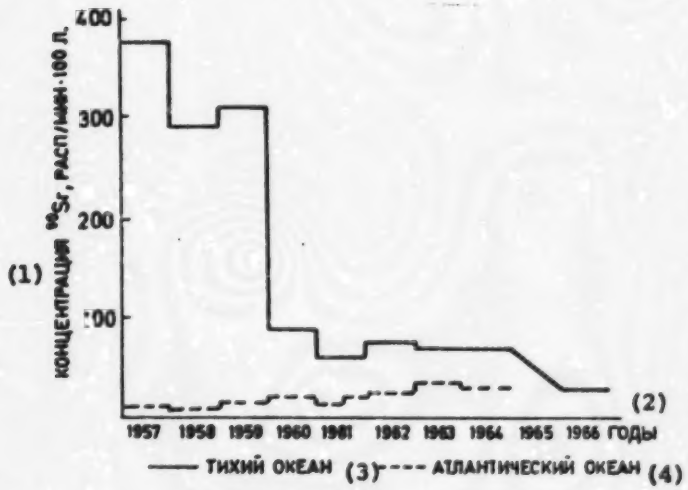

Figure 5. Variation of Sr-90 Concentration in Surface Water of the Northern Pacific Ocean and the Atlantic Ocean During the Period 1957-1966

Key:

1. Sr-90 concentration, disintegrations per minute per 100 liters
2. Years
3. Pacific Ocean
4. Atlantic Ocean

Table 4. Comparison of Mean Sr-90 and Cs-137 Concentration in the Northern and Southern Parts of the Pacific and Atlantic Oceans at Lower Latitudes

(1) Океан	(2) Нуклид	(3) Год	(4) Концентрация расп/мин. на 100 л		(7) Отнош. сев./южн.
			(5) северн.	(6) южн.	
(8) Тихий	(9) Стронций-90	1961 [13,14]	60	30	2,0
	Стронций-90	1966	30	14	2,1
	Цезий-137 (10)		49	24	2,0
(11) Атлантический	Стронций-90	1963 [6]	38	22	1,8
	Цезий-137		77	35	2,2
	Стронций-90	1964 [6]	29	18	1,6
	Цезий-137		50	26	1,9

Key:

1. Ocean
2. Nuclide
3. Year
4. Concentration, disintegrations per minute per 100 liters

[Key continued on following page]

[Key continued from following page]

5. Northern
6. Southern
7. Northern/southern ratio
8. Pacific
9. Strontium-90
10. Cesium-137
11. Atlantic

The mean value of Sr-90 concentration was 57 disinte :ations per minute per 100 liters in the narrow latitudinal zone from 17°S to 23°S. A point in the region of the deepwater Tonga Trench with surface water contamination was found; the Sr-90 concentration was 180 disintegrations per minute per 100 liters. High density of radioactive fallout from the atmosphere was observed in this section when samples were taken. This also apparently explains the increased Sr-90 content at the indicated location (18°47'S and 160°35'W). The Sr-90 concentration was below the range of sensitivity of the method at all depths below the water surface above the Tonga Trench. The Sr-90 content in surface waters was not elevated in any way at other points of this zone. True, according to data of [17], the presence of Ce-141, Ce-144, Ru-103, Zr-95 and Nb-95 was found in zooplankton samples at these same locations. The Sr-90 and Cs-137 concentration in surface waters was not as high in the section from the Tuamotu Archipelago to the California coast. The Sr-90 concentration in the southern hemisphere was an average of 17 disintegrations per minute per 100 liters and it was 35 disintegrations per minute per 100 liters in the northern hemisphere from the equator to San Francisco. The Cs-137 content in the region of Polynesia was an average of 18 disintegrations per minute per 100 liters.

Increased Sr-90 and Cs-137 concentration in the region of the Columbia River delta was found in January 1967 at more northerly latitudes. It was possible to compare our results to data obtained by American investigators in 1964 [18] The mean values in disintegrations per minute per 100 liters in this region were 109 for Sr-90 and 102 for Cs-137 and the ratio of Cs-137/Sr-90 was 0.9 in July 1964 and the values were 78 for Sr-90 and 100 for Cs-137 and the ratio of Cs-137/Sr-90 was 1.3 in January 1967. It was typical for the waters to become much fresher near the mouth of the river in the summer. The river water was characterized by a Cs-137/Sr-90 ratio of approximately 0.3 in the summer. The ocean water had normal salinity (35 percent) and the ratio was approximately 1.8. An intermediate ratio of 1.3 was observed in our case. It is closer to data for the open ocean than to data for river water (70 percent of the water of the open ocean and 30 percent river water); no data were given on the salinity of this ratio. Thus, radioactive contamination in this region was the same in 1967 as in 1964 with lesser contamination of river water. The Sr-90 and Cs-137 concentration in the surface water was significantly higher in absolute value here than at other points of the Pacific Ocean.

Sr-90 content was determined at six points and Cs-137 content was determined at three points in this region in the 100-meter level of water. The values of 100-420 millicuries per square kilometer of Sr-90 and 180-340

millicuries per square kilometer of Cs-137 are completely beyond the range found in the remaining Pacific Ocean basin. Comparison to data on accumulation of fallout Sr-90 [11] shows that global radioactive fallout could produce only approximately 20 percent of the observed content. The content was estimated at approximately 70,000 curies for Sr-90 and approximately 100,000 curies for Cs-137 in the sector of ocean with radius of 435 km, area of approximately 220,000 km^2 and with the center at the mouth of the Columbia River.

The Sr-90 concentration in the Pacific Ocean near the American coast from 35°N to 5°N was approximately the same in 1967 as in the northwestern part of the ocean. It comprised an average of 31 disintegrations per minute per 100 liters for 13 measurements and decreased from north to south.

Summaries of the Sr-90 content in the Atlantic Ocean are presented in [19, 20]. However, the results of measurements only at temperate latitudes are given for 1967. Our investigations of 1967 mainly encompassed the tropical zone of the Atlantic.

The waters of the Caribbean are formed by the northern equatorial current. The mean value of Sr-90 concentration was 11 disintegrations per minute per 100 liters and did not differ from its content in the tropical zone of the ocean. The Sr-90 content in deep waters was below the sensitivity of the method. The Sr-90 concentration in the Yucatan Channel was essentially identical from the surface to 500 meters.

Artificial radioactive products from the mainland apparently enter the Gulf of Mexico. Diffusion and advective transfer result in transformation of water masses then carried away by the gulf stream. An increase of Sr-90 concentration to 18 disintegrations per minute per 100 liters was noted here. The radioactive contamination penetrated to a depth of 1,800 meters at one of the observation points.

Ocean water masses from the north equatorial current move in the western part of the Sargasso Sea. The Sr-90 concentration is within the range of 8-10 disintegrations per minute per 100 liters.

The average Sr-90 concentration was 11 disintegrations per minute per 100 liters in the spring of 1967 in the equatorial zone of the Atlantic Ocean from 5°N to 5°S. No higher concentrations were observed than in the adjacent zones, as was the case in 1963 [6, 20]. The area of abnormally high concentration which was noted in the fall of 1963 also disappeared [6].

There was equalizaton in Sr-90 distribution in the southern part of the tropical zone by 1967; its mean content was 9 disintegrations per minute per 100 liters.

The Sr-90 concentration was an average of 10 disintegrations per minute per 100 liters in the zone from 5°N to 25°S.

Migration of Ce-144, Y-91, Nb-95 and Tc-99 depends largely on the radionuclide content. It is almost impossible to guess which forms correspond to their physicochemical equilibrium in sea water. Specific laws of adsorption, colloid formation and other processes begin to affect the behavior of trace amounts of the substance in solution. The sea medium itself, which contains dissolved and colloidal organic matter, bacteria, marine hydrobionts and suspensions of different composition and origin, plays an important role.

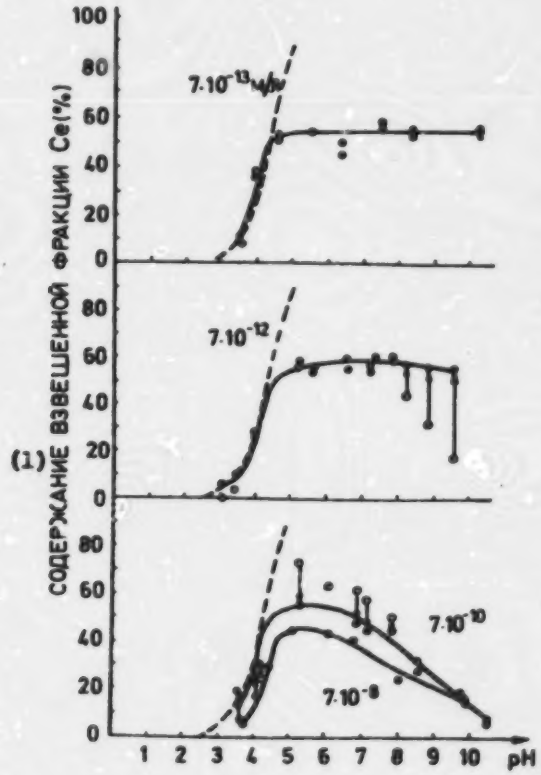

Figure 6. Effect of pH of Solution and of Total Concentration of Element on Formation of Suspended Ce-144 Fraction in Bidistilled Water

Key:

1. Content of suspended Ce fraction (percent)

Laboratory experiments were conducted in "pure" form on bidistilled water. The actual behavior was investigated on samples of sea water. Radioactive elements were introduced to the liquid phase in ion-soluble form.

Ultrafiltration and centrifuging of the solutions and also ion exchange and electrophoresis were used to study the state of radionuclides in the liquid phase. The fraction of the radioactive element that passed through the filter during ultrafiltration or that remained in the upper part of the beaker during centrifuging was regarded as dissolved (provisionally). The remaining part of the element was related to the "suspended" fraction. Ultrasmall quantitites of the elements in the solutions could in turn be found in the ion dispersion, molecular, truly colloidal and pseudo-colloidal states [21, 22].

Investigation of the Ce-144 distribution among dissolved and suspended fractions in bidistilled water as a function of the pH of the solution and concentration in the range of $7 \cdot 10^{-13}$ M to $7 \cdot 10^{-10}$ M showed that cerium remains almost entirely in solution in acid solutions at pH 5 at the given microconcentrations (Figure 6). According to [3], trivalent cerium cannot form truly colloidal $Ce(OH)_3$ particles which could be held on an ultrafilter under these conditions at pH = 9.3. Tetravalent cerium, which yields a colloidal fraction of hydroxide at pH = 3.9, also apparently does not form under the given conditions [24]. If $Ce(OH)_4$ were present in the investigated system, colloid formation at high values of pH would be significantly more intensive. The dashed lines of Figure 6 correspond to the theoretically calculated process of trivalent cerium hydroxide formation [25]. As can be seen from Figure 6, calculations and experimental data agree only on the initial segments of the curves which reflect formation of a suspended fraction. This indicates the occurrence of pseudo-colloids in formation of which dissolved silicic acid apparently plays a role [26]. A decrease of the amount of suspended fraction with a 100-fold increase of cerium ion concentration is apparently determined by processes of ion polymerization. Y-91, Nb-95 and Tc-99 also do not go completely into suspension in bidistilled waters at any values of pH [27-29]

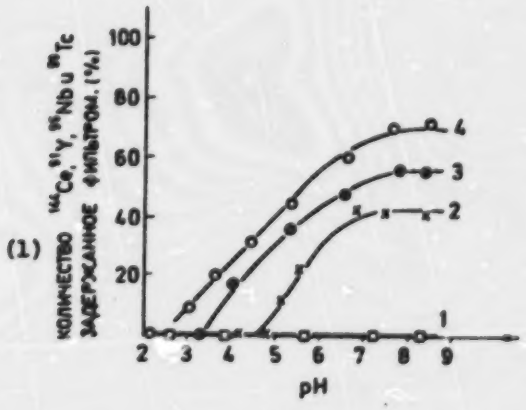

Figure 7. Variation of Quantity of Element Held by Ultrafilter as a Function of pH of Sea Water: 1--Tc-99; 2--Y-91; 3--Ce-144; 4--Nb-95

Key:

1. Amount of Ce-144, Y-91, Nb-95 and Tc-59 held by filter (percent)

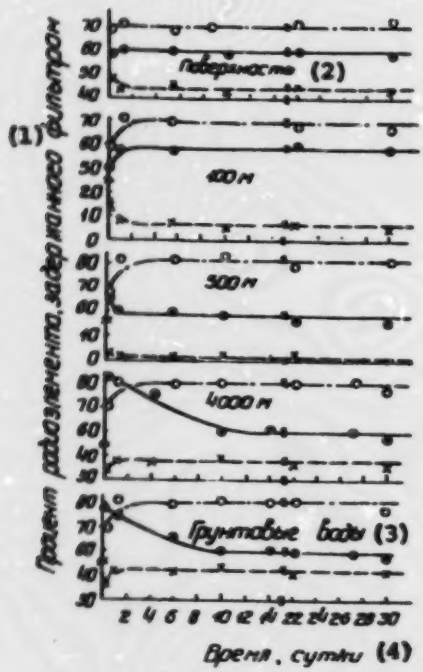

Figure 8. Formation of Suspended Ce-144 Fraction (Solid Lines), Y-91 Fraction (Dashed Lines) and Nb-95 Fraction (Dot-Dash Lines) With Time in Waters Sampled at Different Levels

Key:

1. Percentage of radioactive element held by filter
2. Surface
3. Bottom water
4. Time, days

Besides the hydrolytic properties of the element, its state is affected by adsorption processes in suspensions and complexing with organic ligands in sea water. The composition of the suspension and organic matter is not identical at different points and at different depths in the ocean. Therefore, an element may have different migration capability at different stages of its presence in the ocean. To ascertain this, the transformation of ionic forms of Ce-144, Y-91, Nb-95 and Tc-99 introduced to water samples taken from idfferent levels in the Pacific Ocean at the location of 00°56'N and 160°29'W was studied [30-31].

The hypothesis according to which rare-earth elements (RZE), falling to the sediment on the ocean bottom, can be returned to the water mass due to the effect of complexing with organic phosphorus-containing compounds, was also checked [32]. The behavior of Ce-144, Y-91, Nb-95 and Tc-99 in muddy water obtained from the surface layer of bottom deposits at a depth of 5,173 meters at the location indicated above was considered for this purpose.

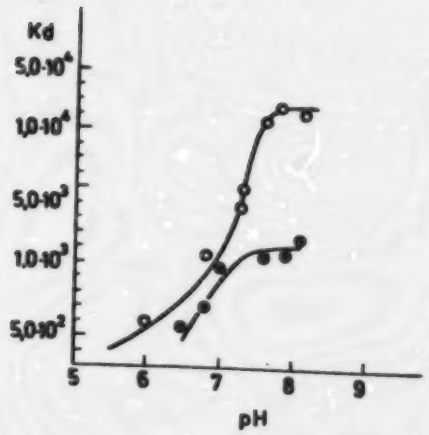

Figure 9. Equilibrium Values of Ce-144 and Y-91 Distribution Coefficients Upon Absorption of Them on Dauex-1 Anion Exchanger from Sea Water: 1--Ce-144; 2--Y-91

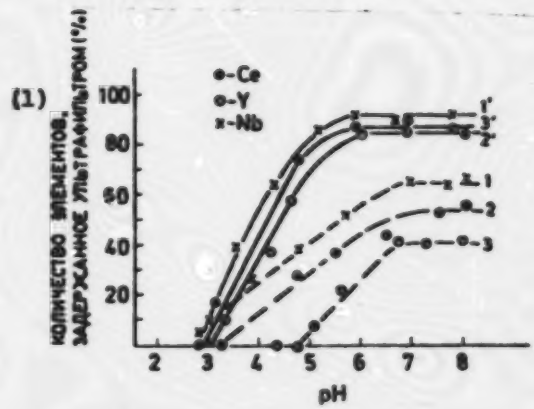

Figure 10. Effect of Iron on the State of Radioactive Elements in Sea Water: dashed lines--natural sea water; solid lines--sea water with addition of 10 micrograms per liter

Key:

1. Amount of elements held by ultrafilter (percent)

Some results of experiments obtained by the ultrafiltration method are presented inFigure 7. One may note that formation of the suspended fraction develops less intensively with an increase of pH than in bidistilled water. Technetium remains in the initial ionic state (ammonium pertechnate)

in the entire range of acidity of the medium. As in pure water, Ce-144, Y-91 and Nb-95 do not go completely into suspension at any values of pH. It was also shown that a reduction of the fraction of suspended Ce-144 is not observed at pH $>$ 7 and concentration greater than $7 \cdot 10^{-12}$ in sea water. This is apparently related to inhibition of polymerization of hydrolyzed ions by foreign impurities in sea water. Another reason is also possible. According to [33], oxidation of Ce^{+3} to a state of +4 is possible in sea water at pH $>$ 7. Because of this, a true colloid of difficult to dissolve cerium compounds, for example, the hydroxide or phosphate, should be formed.

The dependence on the acidity of sea water for Y-91 and Nb-95 is similar to that observed for Ce-144.

The results of investigating the distribution of the studied radioactive elements in water sampled from different depths are presented in Figure 8. The Ce-144 and Nb-95 content in the suspended fraction is essentially identical for water from all depths. The suspended Y-91 content is minimum (0-10 percent) in water from depths of 100 and 500 meters, while it is significantly higher (40-50 percent) in water from the surface, from a depth of 4,000 meters and in water from bottom deposits. Y-91 apparently interacts with some complex-forming agents whose concentration increases from the surface to a specific depth and then decreases again. These are possibly the products of decomposition of organic matter. The difference in the fate of Ce-144 and Nb-95, compared to Y-91, should result in differentiation of these nuclides upon transfer of them to the ocean depths and to faster settling of the former.

Ce-144 and Y-91 distribution between the suspended and dissolved fraction was essentially identical upon separation by ultrafiltration and centrifuging. The latter method permitted calculation of the mean radius of colloidal particles, which is in the range of 0.44-0.05 micron for Ce-144 and 0.20-0.05 micron for Y-91.

The results obtained by the ion exchange method for solutions in bidistilled water easily supplement each other and correspond to theoretical concepts of the interaction of pseudo-colloidal particles with anion and cation exchange resins [23, 34]. The absorption of the investigated radionuclides on a cation exchanger is essentially equal to zero at high values of pH.

Cerium and yttrium from sea water are absorbed only on an ion exchanger (Figure 9). Eighty percent of the Ce-144 and 30 percent of the Y-91 goes from solution to the anion exchange resin with a value of pH = 8.0, typical for natural sea water. Partial absorption of these elements on the anion exchanger and the absence of it in the cation exchanger are apparently related to formation of negatively charged particles during hydrolysis. The difference in separation of the investigated elements by ultrafiltration (by centrifuging) and by means of ion exchangers is apparently related to

formation of colloidal aggregates with sea water phosphates and soluble complex compounds with organic ligands, besides negatively charged particles. The results are in good agreement with data of electrophoretic investigations which indicate the appearance of negatively charge particles at pH > 7.5, which have a positive charge in the range of pH < 7.

Thus, upon entering sea water, the investigated radioactive elements are hydrolyzed with formation of negatively charged colloidal particles (pH = = 7.8-8.2). Moreover, Y-91 apparently forms neutral charged particles with phosphates and soluble complex compounds with organic ligands.

One of the constituent parts of the organic suspension is living matter which continually removes chemical elements from sea water and brings them into the biological circulation system. Another important component of the ocean's suspension is iron and its content in suspended matter fluctuates from 0.5 to 19.5 percent [35], 36]. Yielding a hydroxide, it may participate in extraction of elements from sea water.

Therefore, the effect of iron on the state of Ce-144, Y-91, Nb-95 and Tc-99 in sea water was investigated (by the ultrafiltration method).

The results are presented in Figure 10, from which it is obvious that Y-91, Ce-144 and Nb-95 go into suspension by almost 90 percent upon introduction of an additive quantity of iron. There is a total of 45 percent Y-91, 60 percent Ce-144 and 70 percent Nb-95 in the suspended state in natural sea water. The presence of iron does not effect the physicochemical state of Tc-99. The data clearly indicate the danger which results in disposal of radioactive elements in the ocean. Entering plankton organisms during feeding, iron serves as its own kind of carrier of fission fragments and contributes to implication of the investigated radioisotopes in the active biological cycle.

It was established that the coefficient of accumulation of all the isotopes in the presence of iron by plankton is an order higher than in the sea water-plankton-isotope system. The effect of the specific composition of the plankton was not loaded in this case.

Besides biogenic processes affecting the distribution of radioactive elements in sea water, abiogenic processes--uptake of isotopes by the suspension surface and bottom sediments--were also investigated.

With regard to the fact that the composition of the suspended matter is not uniform in depth, it was of interest to study the uptake of radioactive isotopes by suspension from different depths of the ocean. These samples were taken at depths of 0, 100, 500 and 4,000 meters at the location indicated above and also from the surface in different areas of the tropcial part of the Pacific Ocean. It was found that, regardless of the geographic location of the sample, the amount of Ce-144, Y-91, Nb-95 and Tc-99 extracted by suspension from the water is identical almost everywhere (Table 5).

Table 5. Uptake of Investigated Radioactive Elements by Surface Suspension

№ образца взвеси (1)	Середина района сбора пробы (2)		Захват радиоэлемента, K_d (5)			
	широта (3)	долгота (4)	^{91}Y	^{95}Nb	^{99}Tc	^{144}Ce
1	22°42'N	170°34'З	$4{,}1\cdot10^3$	$5{,}8\cdot10^3$	0	$1{,}9\cdot10^3$
2	12°25'N	156°36'З	$4{,}3\cdot10^3$	$5{,}6\cdot10^3$	0	$1{,}9\cdot10^3$
3	21°06'С	173°04'З	$4{,}5\cdot10^3$	$6{,}1\cdot10^3$	0	$1{,}9\cdot10^3$
ст. 5892 (6)	0°59'С	160°29'З	$4{,}3\cdot10^3$	$6{,}2\cdot10^3$	0	$1{,}7\cdot10^3$

Key:

1. Number of sample of suspension
2. Middle of sampling region
3. Latitude
4. Longitude
5. Uptake of radioactive element, K_d
6. Station

Study of the uptake of radioactive elements sampled at different depths by suspension showed that this process is quantitatively dependent on the properties of the suspension and its granulometric composition. It was noted for the investigated radioactive elements that the minimum uptake is confined to the surface suspension and it increases in proportion to the sampling depth. The maximum value was determined for the deep-sea suspension where mineral grains are a significant part of its composition. The irreversibility of radioisotopes taken up is also noted at these levels.

Phenomena of repeated dissolution and mineralization of suspensions and biological processes participate actively in migration of radioactive elements taken up by suspension. Being taken up by newer and newer plankton organisms as a result of frequent replacement of their generations, the radioactive elements remain in the biological sphere and are transferred from lower organisms to higher organisms, creating immediate danger to man, despite the opinion of the limited dilution of radioactive elements in the ocean.

More widely distributed and typical oozes sampled in the Indian and Pacific Oceans were taken to study the effect of bottom sediments on the distribution of radioactive elements in the ocean. The results of quantitative extraction of the investigated radioisotopes from sea water by bottom sediments showed that Ce-144, Y-91 and Nb-95 take up more completely silt which is contained in the thin fractions of more than 50 percent kaolite. A somewhat lower percentage of isotopes (approximately 85) is related to tropical Radiolaria by finely aleuritic silt containing more than 16 percent amorphous silica in the form of skeletal remains of plankton organisms --Radiolaria and partially diatom algae. Lesser extraction of isotopes is typical for slightly calcareous clay oozes (80 percent). Sediments with high calcium content (approximately 60 percent) and volcanic sand (approximately 75 percent) take up radioisotopes worst of all.

Thus, the investigated bottom sediments can be arranged in the following order by the extent of uptake of isotopes from sea water: noncarbonaceous clay ooze > tropical finely aleuritic Radiolarian ooze > slightly calcareous clay ooze > volcanic sand > carbonaceous ooze.

The data clearly indicate that the degree of uptake of elements by bottom sediments is a direct function of the surface area and the chemical composition of the latter. For example, one of the good concentrators of isotopes--finely aleuritic ooze--has very developed surface of 32.5 m^2/g and contains 16.3 percent amorphous silica and 1 percent calcium carbonate, while carbonaceous ooze, which is related to worse absorbers, has a surface of only 0.61 m^2/g, there is no amorphous silica in its composition and it consists almost entirely of calcium carbonate (93.5 percent).

Thus, as a whole the extraction of radioactive elements from sea water by bottom sediments is a complex physicochemical process which is a combination of the process of mechanical uptake of colloidal particles of these elements by oozes and of absorption, the part of the radioisotope which is in sea water in a truly diluted state.

The results outlined here in combination with data of [5-7] provide a pattern of radioactive contamination of the oceans in 1966-1967. The initial situation for further study of the radioactivity of one or another section of the ocean is given for the first time by each investigated region.

By 1966-1967, radioactive contamination of the surface waters of the ocean was reduced as a whole and some previously existing radioactive areas had become diffused. The Sr-90 content, which decreased with depth, clearly exceeded the amount in the Pacific Ocean which was deposited due to global radioactive fallout. Similar reliable data were found only at some points in the Atlantic Ocean.

The main circumstance which causes alarm is the presence of technogenic radioactive regions in international waters and the tendency toward an increase of their number, the intensity of contamination, dimensions and also toward fusion of these regions with each other.

To understand what may occur with the sea and its resources in the future, the physicochemical and biological processes which control radionuclides discharged into the ocean are being studied. Hydrolysis, complexing and concentration in the ocean suspension play an important role for the soluble forms of some radioactive elements. The implication of artificial radionuclides in the active biological circulation may result in accumulation of them in some links of the migration chain. Among the different types of bottom sediments, the best absorber of the investigated radionuclides is noncarbonaceous clay ooze. The mechanism of extracting these nuclides from sea water is a combination of mechanical uptake of colloidal particles of these materials by bottom sediments and by absorption on them

of the part of radioactive elements which is in sea water in a truly dissolved state.

It follows from the data given here that radioactive waste disposal in the oceans presents a specific danger. Taking into account the vigorous development of the nuclear industry and power engineering, effective measures must now be found to prevent further radioactive contamination of the oceans and seas.

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MIGRATION OF RADIONUCLIDES IN FORESTS, AND EFFECTS OF IONIZING RADIATION ON TREE PLANTATIONS

New York City PROCEEDINGS OF THE FOURTH INTERNATIONAL CONFERENCE ON THE PEACEFUL USES OF ATOMIC ENERGY in Russian Vol 11, 1972 pp 675-688

[Article by F. A. Tikhomirov, R. M. Aleksakhin and Ye. A. Fedorov, USSR Ministry of Higher and Secondary Specialized Education, Moscow, Union of Soviet Socialist Republics]

[Text] Introduction

The study of the patterns of distribution and migration of artificial radioactive substances in various elements of the environment and of the effects of ionizing radiations on communities of plants and animals is a task that is important in both the practical and theoretical respects. Tree biogeocenoses occupy a special place among natural communities. Forests as a landform, that occupies a significant part of land, have a strong influence on the distribution and migration of radioactive substances in the biosphere on a global scale, preventing development of processes of radionuclide transport by wind and water over the earth's surface, while the cycle of synthetic radionuclides in them is characterized by unique distinctions that are specific only for forest cenoses.

The forest is a system that is very sensitive to ionizing radiation; it is damaged by radiation in doses that do not induce noticeable disturbances in other types of phytocenoses, in particular in communities of herbaceous plants. For this reason, the study of the patterns of migration of artificial radionuclides in forests and effects of ionizing radiation on tree cenoses is of practical interest, from the standpoint of both evaluation of radiation effects when radioactive substances are discharged into the environment and investigation of the possibility of commercial utilization of tree products with high radionuclide content. In addition, the study of processes of migration of radionuclides in forests opens up the possibility of gaining fuller knowledge about the mechanisms and patterns of biogeochemical processes and the cycle of chemical elements in tree biogeocenoses, while the study of radiation effects will definitely aid in gaining deeper understanding of the structural and functional distinctions of forest cenoses as self-regulating systems.

In this paper, we submit the results of experimental studies of forest radioecology, which were pursued for many years in the USSR and directed toward two main objectives: analysis of the patterns of distribution and migration of radionuclides in forest cenoses, and study of the consequences of irradiating forests, which are comprised of effects attributable directly to radiation and secondary phenomena related to changes in structure and biogeocenotic relations in an irradiated cenosis [1]. These results sum up the information obtained from a series of experiments involving introduction of radionuclides in forest plantations by means of spraying the crowns with radioactive solutions and putting them under the canopy, as well as the data obtained from observing distribution and migration of synthetic radionuclides in forests after global and one-time local fallout.

Migration of Radionuclides in Forests

Primary interaction between tree plantations and radioactive fallout: When transported by the wind, the radioactive particles are trapped the most effectively by trees standing on the edge of a forest. According to our observations, 2-5 times more radionuclides settle on the crowns of forest edge trees than the fallout on adjacent treeless areas; the "edge [of forest] effect" is demonstrable at a distance of 15-20 m from the edge of the forest.

For quantitative description of interaction between radioactive fallout and vegetation the coefficient of retention is generally used; it refers to the share of radionuclides retained by the above-ground part of plants. The magnitude of this coefficient is related to the type and age of the tree stand, seasonal and meteorological conditions, as well as physicochemical forms of nuclides. According to our observations, the coefficient of retention fluctuates over the following range, depending on specific conditions:

Pine seedlings, 6-10 years old, crown density 1.0	Crowns sprayed with ^{89}Sr solutions	90-100%
Pine plantation, 60 years old, crown density 0.9	Fallout of particles up to 50 μm in size	80-100 %
Pine plantation, 25 years old, crown density 0.8	Fallout of particles up to 100 μm in size	70-90%
Pine plantation, 30 years old, crown density 0.8	Fallout of secondary (soil) particles raised from the surface by wind	40-60%
Birch plantation, 40 years old, before leaves open, crown density 0.8	Fallout of secondary (soil) particles raised from the surface by wind	20-25%

Thus, tree vegetation is characterized by a higher retention capacity with respect to radioactive fallout than herbaceous vegetation (for which the coefficient of retention constitutes a mean of 25% [2]. This is attributable to the large biomass of the crowns, better separation thereof and high ratio of leaf and needle surface to weight thereof, for which reason the canopy plays the role of a filter that is capable of retaining a significant amount of radioactive dust. Since dry radioactive fallout hits the ground in relatively small amounts by weight, which are not sufficient to saturate the crowns completely, the coefficient of retention of radioactive fallout by the forest canopy can apparently be considered to equal the degree of compactness [density] of crowns, with the exception of forests of deciduous trees, during the period they are without leaves. In this case, the forest canopy has a retention coefficient that is about one-third the quoted figure.

Cycle of radionuclides in forests: Vertical and horizontal migration begin immediately after radionuclide fallout, under the influence of the wind and atmospheric precipitation, as well as shedding of trees, as a result of which the radionuclides gradually migrate from the top parts of the crowns to the lower ones and then under the canopy.

Seasonal conditions, the role of which we demonstrated in experiments involving spraying pine seedling crowns with ^{89}Sr solutions, are an important factor that affects the rate of removal of radionuclides from crowns. When ^{89}Sr was applied to the crowns in the summer (June), they were relatively rapidly cleared of it, in spite of the dry weather (3 mm rain in the first 2 weeks). The half-life for removal of ^{89}Sr as related to the entire above-ground biomass, constituted about 3 weeks under such conditions. When ^{89}Sr was applied in the fall (October), the rate of self-purification of crowns was significantly lower: half-life for elimination from the crowns as a whole (without counting radioactive fallout) constituted about 4 months, i.e., 5.5 times longer than when used in the summer (Figure 1).

The experimental data pertaining ot distribution of radionuclides penetrating into tree crowns in the form of solid particles indicate that removal of contaminants from the above-ground part of the tree stand also depends, in this case, on the time of year when the fallout occurred. Thus, according to our observations, when there was radioactive particle fallout in the spring, the half-life for migration from the crowns of pine tree stands constituted 4 months, versus 10-12 months in the case of autumn fallout (Figure 2). Thus, elimination of fallout from the above-ground part of adult tree stands is 10-12 times slower than for herbaceous vegetation, for which the half-life for elimination of the most important fission products contained in radioactive fallout constitutes 12-14 days [3].

The rate of migration of radionuclides under the canopy of crows in the case of fall and winter fallout depends on the type of forest. According to our data, in deciduous forests, over 50% of the radionuclides entering the crowns migrate to the forest floor after the leaves fall in autumn.

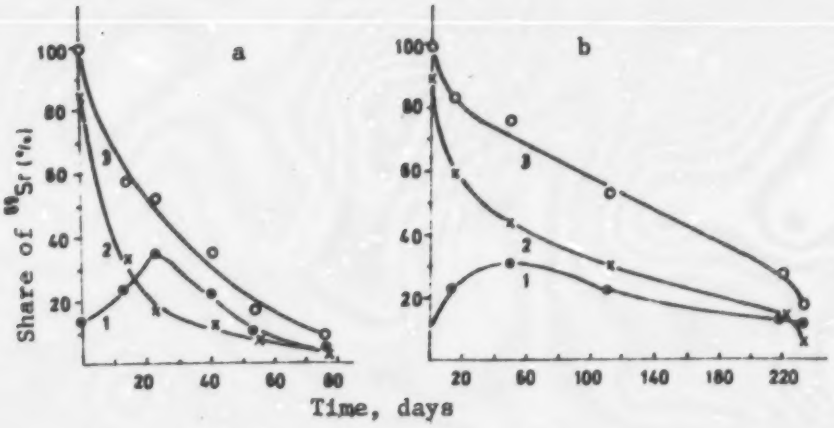

Figure 1. Change in ^{89}Sr content of pine crowns when the radionuclide is used in the summer (a) and autumn (b) (% of total levels) in: 1) branches, 2) needles and 3) needles + branches

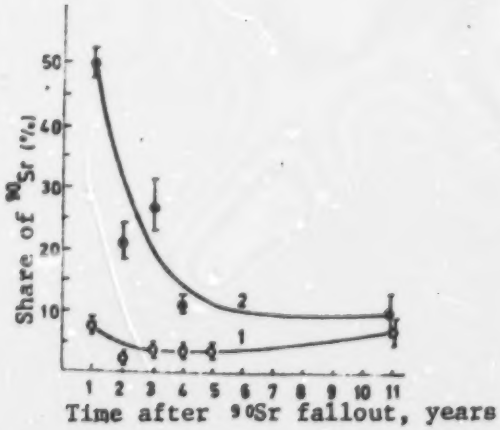

Figure 2.
Changes in ^{90}Sr content in aboveground part of birch (1) and pine (2) forests (% of total level in cenosis) after single fallout

Concurrently with vertical migration of radionuclides from the crowns into the ground, there is redistribution over the level [height] of the crowns. The radionuclides pass from the overstory to the lower part of of the crown canopy, where the effect of rain and wind is less marked, as a result of which the radionuclide content in the bottom part of the crowns is several times higher than in the top part. After a certain time, most of the radionuclides are concentrated in the forest floor and soil. This initial stage of redistribution of radionuclides in the forest cenosis is largely irreversible. Experimental studies of the cycle of ^{90}Sr over a period of many years in adult birch and pine forests after single fallout of this radionuclide revealed that this stage, during which up to 90% of the radionuclide migrates under the forest canopy, lasts about 1 year in birch plantations and 3 to 5 years in conifer forests, and this is related to the longer life of pines and rougher surface of the branches (Figure 3).

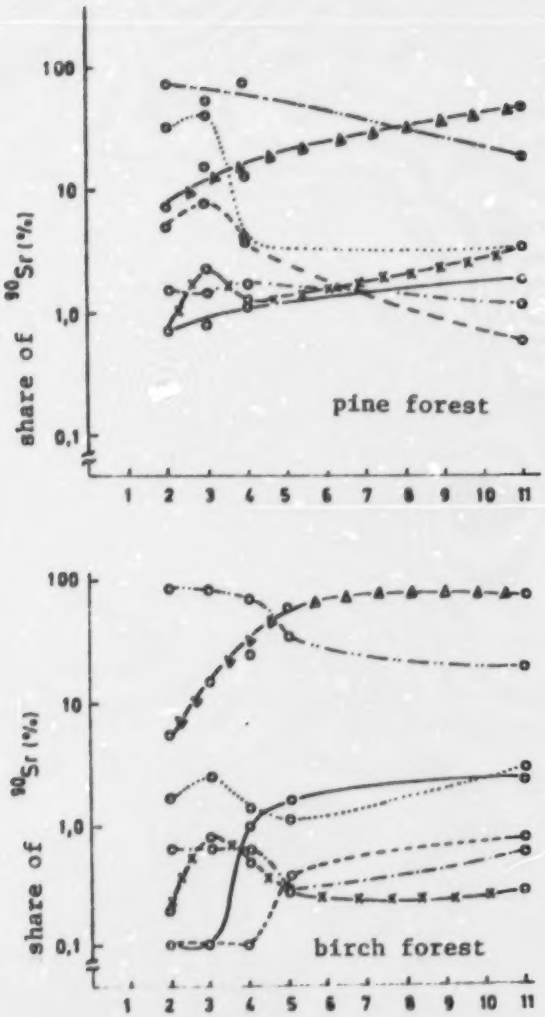

Figure 3.
Changes in ^{90}Sr content in different components of forest cenosis (% of total) after single fallout
0) experimental data
..) forest floor
) soil
-) wood pulp
-.-) bark
---) leaves (needles)
...) branches
x) grassy vegetation

After this stage, the soil becomes the main source of radionuclides in the above-ground part of trees. According to our observations, the period during which 50% of ^{90}Sr fallout in the course of migration of radionuclides under the forest canopy and mineralization of the forest floor migrates into the soil and becomes accessible to assimilation by the roots constitutes about 4-5 years for the birch forest and 8-9 years for the pine forest, which is attributable to differences in rate of self-purification of crowns and rate of mineralization of the forest floor in deciduous and coniferous forests. To forecast the maximum levels of accumulation of radionuclides in the above-ground perennial parts of trees, we considered the fact that upon reaching equilibrated distribution, the ratio of radionuclide concentration in the biomass to its concentration in soil should equal the corresponding ratio of concentrations of stable isotopes of a given element:

$$\frac{C_{rad.\ plant}}{C_{rad.\ soil}} = \frac{C_{stab.\ plant}}{C_{stab.\ soil}}$$

A good conformity was obtained of estimated concentrations with the actual maximum concentrations of ^{90}Sr in wood pulp, which are reached in the pine and birch forests 5 years after radioactive fallout (Figure 4) [4].

The distribution of radionuclides in a forest cenosis is close to a state of relative dynamic equilibrium 10 years after radioactive fallout, in which the annual transfer of radionuclide from the soil to the above-ground part exceeds the reverse

migration only by the amount corresponding to the increment in the current year of this nuclide in the biomass.

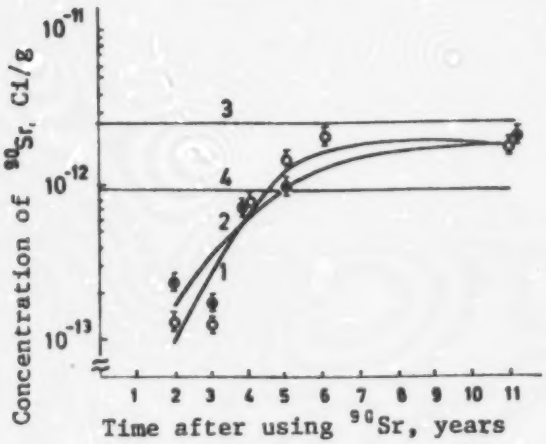

Figure 4.
Accumulation of ^{90}Sr in wood pulp of birch trees (1) on chernozem and pine trees (2) on podzol soil. ^{90}Sr content in cenosis 1 mCi/m^2. 3, 4—estimated maximum concentrations of ^{90}Sr in birch and pine pulp, respectively

Dosimetry of Ionizing Radiation in Forests After Radioactive Fallout

When there is radioactive fallout in forests, the highest doses of radiation are received by the assimilating organs of trees and tissues of the apical meristem. On the one hand, this is due to the fact that these organs are open and most of the radionuclides settle in them. On the other hand, the size of these organs is commensurate with the range of β-particles emitted by fission products, and all of the cells of these tissues are accessible to γ-radiation; most of its energy is absorbed in them. For this reason, although β-radiation does not play an appreciable role in external irradiation of the cambial meristem and dormant buds, which are protected from radioactive fallout by a layer of bark, it makes the main contribution to the radiation dose to leaves, needles and apical meristem tissues.

In order to determine the correlation between radionuclide content of crowns and radiation doses, special experiments were conducted, with spraying of ^{89}Sr solutions on the crowns [5]. The doses of β-radiation were measured with photodosimeters placed on different parts of the crowns. The doses absorbed within the meristematic tissues (particularly the "soil" [probably typo for buds]) were estimated on the basis of distribution of the radionuclide in such tissue, the dosage to the bud surface being normed to the dose measured by the photodosimeters. Thus, when scaled to 1 $mCi\ ^{89}Sr/m^2$, the total dose constituted about 170 rad in needles and 90 rad in bud meristem when the radionuclide was sprayed in the summer, 550 and 300 rad, respectively, i.e., 3.2 times more, when used in the fall.

The reduction of absorbed dose in bud meristems is due to the fact that these tissues are significantly protected against external β-radiation by the bud scales; only a negligible part of the radionuclide applied penetrates into the buds through the scale surface.

Radiation Damage to Trees by Radioactive Fallout

The main patterns of effects of ionizing radiation on trees in cases of radioactive fallout have much in common with the effect on tree plantations of very penetrating radiation (γ-quanta, neutrons) from point sources, which has been described comprehensively on the basis of research conducted in the United States involving exposure of some segments of a forest to radiation [6, 7]. At the same time, there are some specific distinctions to radiation damage to trees from radioactive fallout, which are related to the distribution of radiation sources, which changes in time and space, and consequent changes in dose fields in a forest biogenocenosis.

Effect of radioactive fallout on woody plants: Radiologically, woody plants are the most vulnerable component of a forest cenosis with regard to radioactive fallout. On the one hand, this is due to the great intensity of β-radiation in the crowns at the early stage and, on the other hand, the relatively high radiosensitivity of trees, particularly conifers. We studied the radiation effects of β- and γ-radiation of radionuclides falling on tree crowns the most comprehensively in common pine (Pinus silvestris) and common birch (Betula verrucosa). As in the case of external γ-radiation, they present a decrease in growth increment, inhibition of needle and runner growth, dying off of needles and buds and formation of new buds and runners, double increment, impairment of monopodial branching, phenological changes manifested by delayed opening of leaves in stricken trees.

The specifics of radiation damage to trees caused by fallout refer to the fact that when radionuclides fall in the form of relatively large particles (up to 100 μm), the damage to leaves, needles and tissues of the apical meristem is manifested primarily in the lower and upper parts of the crowns, particularly on the windward side. The top runners remain viable when up to 95% of the crown dies, and the apical meristem of the main runner remains intact, even though it is among the most radiosensitive tissues of the tree. This is attributable to relatively rapid decontamination of the apical runners under the influence of the wind and atmospheric precipitation. Unlike this, with exposure of trees to external γ-radiation from point sources, the apical meristem is the first to be injured, and the crown starts to dry at the apical runner.

A comparison of resistance of conifers and deciduous trees to fallout revealed that the differences in resistance to summer fallout are mainly attributable to species-specific differences in radiosensitivity (birch

trees are 5-7 times more resistant than pines). But if fallout levels are taken as a criterion of resistance, the differences between pine and birch are even greater (by about 20 times) in the case of fallout in the autumn and winter, because of the decreased retention of fallout (and consequently radiation dose) in the crowns of deciduous trees after they have shed their leaves.

Resistance of woody plants to radiation depends significantly on the physiological state. Thus, when ^{89}Sr is sprayed on pine crowns when the trees are in a state of physiological dormancy, lethal doses of radiation (absorbed dose in needles 3200 rad) were 1.6 times higher than when the radionuclide was applied during the vegetation period (2000 rad). According to Sparrow [8], the seasonal differences in radiosensitivity of trees are attributable to an increase in volume of meristem cell nuclei (by about 1.6 times) when they make the transition from winter dormancy to active growth.

The ratios we obtained between radionuclide content of the crown and β-radiation dose rate, and our comparison of the observed radiation effects to dosage enabled us to determine the overall radiation damage to forests after fallout from a mixture of fission products. According to our data, the contribution of β-radiation to the total dose accreted in leaves and needles is several times greater than that of γ-radiation, since most of the energy of β-radiation of radionuclides in the crowns is absorbed in the crown biomass, whereas the share of energy from γ-radiation absorbed by the above-ground part of the tree stand constitutes no more than 10% of its total energy. The total energy of β-radiation from a mixture of fission fragments at the age of up to 100 days is close to the total energy of γ-radiation, and for an older mixture it could be several times greater.

Thus, our results are indicative of the important role of β-radiation in radiation damage to forests. For example, in the case of fallout on a forest from a fresh mixture of fission products during the vegetation period, the ratio of contributions of β- and γ-radiation to the dose absorbed in leaves, needles and apical meristem tissues may reach 9:1, and with increase in age of the mixture the contribution of β-radiation would be even greater. If, however, the fallout occurs in late autumn or winter, the fallout levels that kill woody plants will be considerably higher (by 1.5-2 times for evergreen conifers). The seasonal differences in lethal levels of fallout would apparently be even greater (5-6-fold) for woody plants that shed their leaves (or needles) in the winter, since most of the radionuclides from winter fallout will directly go under the forest canopy without being retained in the crowns.

Effect of radioactive fallout on organisms under the forest apron: After radionuclides migrate under the apron, they concentrate in the thin layer of forest floor, creating rather high doses of radiation in it and adjacent layers of soil and air. This is precisely the area where plant seeds fall

and where numerous species of various animals live--worms, insects, Arachnida and small mammals (myomorphs and insectivores). Experiments dealing with the effects of ^{90}Sr and ^{90}Y β-radiation on conifer seedlings--pine, fir and larch--revealed [9] that irreversible damage to seedlings of this species begins with an absorbed dose rate of 10-15 rad/day, which corresponds to 6-9 mCi $^{90}Sr + ^{90}Y/m^2$ in the top layer of soil. With such levels, seedlings cease to grow and perish in the third year of their life. With an absorbed dose rate of 4 rad/day (3 mCi $^{90}Sr + ^{90}Y/m^2$) radiation, no irreversible damage is caused, although there is a decline of growth rate. In the fourth year of life, the seedlings begin to show satisfactory growth.

When the fallout levels are high enough and the crowns of trees are damaged by radiation, the direct effect of ionizing radiation on organisms living under the forest canopy is combined with the effect of altered microclimate (increased light, elevation of temperature of top layer of soil, etc.) due to thinning of the crowns under the effect of radiation. For this reason, the resultant effect of radioactive fallout on the population of these organisms is determined not only by their radiosensitivity, but adaptability to altered environmental conditions.

Let us consider the changes in composition of grass cover after fallout of long-lived radionuclides on a forest as an illustration of the combined effect of these factors. There was a 3-5-fold increase in grass cover biomass in plantations where pine trees died of irradiation and birch trees were severely damaged (30% of the trees dried up). At the same time, there was a change in species composition of the association. According to the data of Ye. G. Smirnov, bush grass (Calamagrostis epigeios), a plant capable of vegetative reproduction from rhizomes protected by a layer of soil from β-radiation, became the dominant species in the association 2-3 years after the fallout. This species was also rather widespread under the canopy of the control plantation. As time passed, the following plants also became dominant: Chamaenerium angustifolium, Centaurea scabiosa and Cirsium setasum, which are photophilic tall species, and pioneers with a powerful root system that eject radioresistant but relatively short plants, such as Eragaria vesca, Carex precos and a few others.

The long-term presence of populations of plants and animals in an environment with a high background of ionizing radiation triggers adaptation mechanisms directed toward adjustment of organisms to these altered conditions. Increase in radioresistence (radioadaptation) is one of the manifestations of adaptation. According to our data, the incidence of chromosomal aberrations in seedling cells and young plants was lower after additional "stimulating [provocating]" γ-irradiation of seeds of plants that had been growing for 7-10 years in an area with high concentration of ^{90}Sr (0.3 mCi/m^2) than when seeds from plants in a control plot were irradiated (Figure 5). It can be assumed that, in the case of chronic exposure to a high background of ionizing radiation, there is elimination

from a population of organisms that is heterogeneous in radiosensitivity of the more radiosensitive specimens and selection of the more radioresistant forms.

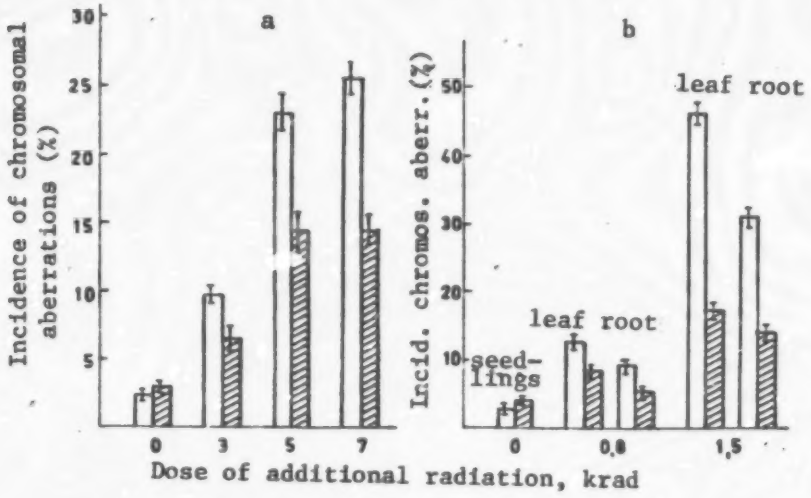

Figure 5. Change in incidence of chromosomal aberrations as a function of dosage of provocating radiation in plants from control (white columns) and experimental (striped) plots

a) Vicia crocca L. (seedlings) b) Agrimonia eupatoria L.

Direct irradiation and alteration of the structure of the forest cenosis and microclimate as a result of radioactive fallout have an appreciable influence on forest fauna as well. These changes can be illustrated by the results of our observations of the gipsy moth (Lymantria dispar), which is a widespread primary pest in forests of the temperate zone (Figure 6).

Exposure of eggs to chronic radiation in doses of $n \cdot 10^1$-$n \cdot 10^2$ rad stimulated hatching of caterpillars, while higher doses ($n \cdot 10^2$-$n \cdot 10^3$) caused appreciable decrease in hatching. Radiation did not have an adverse effect on survival of caterpillars living in the same parts of the forest, since the radiation dose to the crowns, where the caterpillars feed at this stage, were significantly lower than near the surface of the ground. Moreover, we found that the higher the radionuclide content in a given area, the higher the survival rate of caterpillars. This is attributable to the decrease in number of tachina flies, which parasitize on gipsy moths, under the influence of radiation. The high sensitivity of tachina flies to radioactive fallout is attributable to the fact that they hibernate on the

forest floor (at the pupa stage), where rather high doses of radiation are generated (up to 30 rad/day absorbed dose rate) and where they undergo metamorphosis.

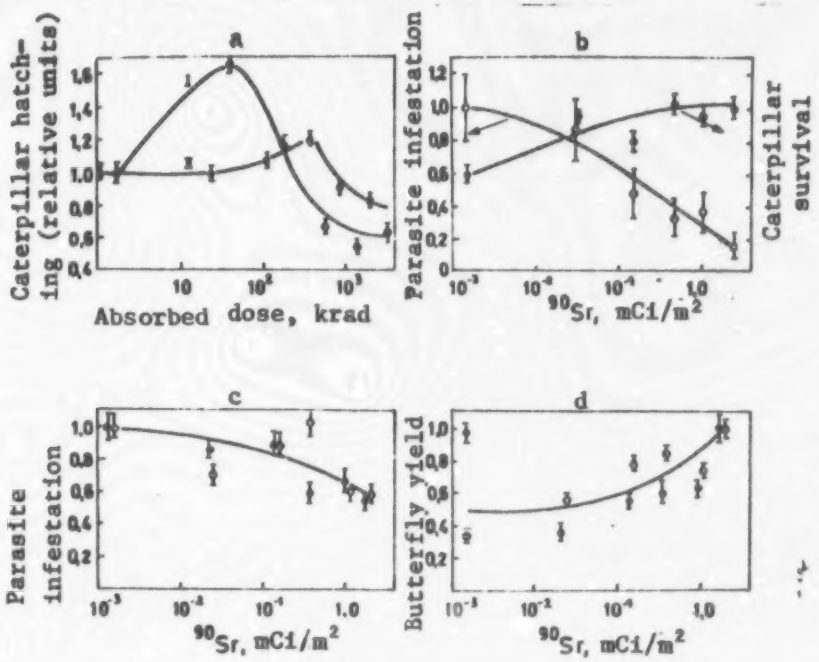

Figure 6. Effect of single ^{90}Sr fallout on population of gipsy moths and their parasites, tachina flies

a) caterpillar hatching as a function of radiation dose
b) infestation of caterpillars by tachina fly larvae and caterpillar survival as a function of level of ^{90}Sr fallout
c) infestation of pupae by tachina fly larvae
d) yield of butterflies as a function of level of ^{90}Sr fallout
ϕ ϕ) experimental data for two successive generations of gipsy moths

There is an analogous, though less marked, correlation between extent of parasite infestation and survival of the "host" as a function of fallout level in the gipsy moth at the pupa stage. In addition to irradiation and parasite activity, other factors (change in influx of heat and light under the forest canopy, increased airing of crowns, impairment of food chain manifested by impaired coordination of leaf opening and caterpillar hatching, etc.) have an appreciable influence on size of gipsy moth population. We used the number of eggs laid per unit area as an integral criterion reflecting the combined effect of all factors influencing the number of gipsy moths in forests damaged by radiation. We found that there was a decrease in eggs laid with increase in fallout level, and

this decrease is unrelated to a decrease in amount of food, since there was less damage by caterpillars to leaves in areas with high radionuclide content than those with a low one, although the store of food per oviposition was significantly lower in the former case.

Changes in populations of herbivorous myomorphs [mouse-like rodents] could be another example of the effect of radioactive fallout on animals in forests. As a result of development of a good grass cover under the canopy of the damaged plantation, favorable conditions are created for mass scale reproduction of the rodents, which can survive in the presence of a rather high radionuclide content in the forest. Thus, Il'yenko [10] established that introduction of ^{90}Sr under the forest canopy, in doses of 0.6-3.4 mCi/m^2, did not have an appreciable influence on the life span of small rodents. Radiation only led to an increase in variability of morphological, craniological and other features of the populations, which expands the potential adaptability of the populations to existence in areas with a high levels of ionizing radiation.

Recovery of forests: The capacity of tree stands to recover from damage caused by ionizing radiation depends on the type of forest and extent of damage. Under our experimental conditions, the plantations of deciduous trees--birch and aspen [sic?]--retained the capacity for recovery by forming root or stump shoots when the crowns of the trees had dried completely. Thus, in the area where 70% of the new growth and 30% of the overstory of birch trees had died as a result of radioactive fallout, profuse growth of stump shoots appeared after 1.5 years, which were quite viable and developed for many subsequent years. In the case of partial damage to wood plants, they recovered after 8-10 years, even after 95% of the crown had dried. Since the apical runners usually remained undamaged in such a case, after restoration of the crowns the appearance of these trees did not differ from normal ones.

Thus, the results of our studies indicate that forests, as a component of the landscape, are among the most sensitive biological systems with regard to radioactive fallout. Ionizing radiation excludes from the forest biogeocenosis the most radiosensitive species and subsequently impairs its structure, due to changes in biogeocenotic relations between the different elements of the cenosis. Studies of cenotic reactions to radioactive fallout are still at the first stage. Deeper knowledge of the patterns of distribution of radionuclides in forests and of the effects of ionizing radiation on forest biogeocenoses is the objective of future studies.

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PROSPECTS FOR EXTENSIVE PEACEFUL UTILIZATION OF ATOMIC ENERGY WITHOUT RADIATION RISK TO THE POPULATION

New York City PROCEEDINGS OF THE FOURTH INTERNATIONAL CONFERENCE ON THE PEACEFUL USES OF ATOMIC ENERGY in Russian Vol 11, 1972 pp 703-709

[Article by Yu. A. Izrael' and E. N. Teverovskiy, USSR Main Administration of Hydrometeorological Service, Moscow, RSFSR]

[Text] Energy, released during the transformation of atomic nuclei, is used more and more widely by man. Atomic energy is the main new trend in the development of energy. [1].

At present the centers of atomic energy are atomic electric power plants (AEP) which use U^{235} fission by fuel neutrons. The projected development of nuclear energy is related to fast neutron reactors using U^{238}.

It is expected that the general use of energy by the year 2000 will reach 2.1×10^{10} tons of conventional fuel and the capacity of electric power plants will increase to 1.1×10^{7} M W [3,2]. The percentage of atomic electric power plant capacity out of the total electric power plant capacity will increase from 1.3 percent to approximately 50 percent [2] and will reach 3×10^{6}, and according to some findings, 5.5×10^{6} MW [2,3].

The efficiency coefficient (e.c.) of the atomic electric power plants is now 25-30 percent, in the future it may increase to 42-45 percent [2].

In addition, in the coming years we can expect the development of new uses of atomic energy in industry and construction.

It is exceedingly important that the development of nuclear energy not lead to harmful or even dangerous effects as a result of the possible release of certain quantities of radioactive products of nuclear reactions into the environment. This factor can be a real (and perhaps, a decisive) influence on the development of nuclear energy as a whole as well as on the development of some of its branches. More attention is being paid to the problems of the effect of nuclear energy on the environment [3,4].

No any one branch of industry has such protective measures against possible environmental pollution as nuclear energy [3]. In spite of this, more and more effective measures are being implemented, possible emission doses in the immediate vicinity of the plants are being evaluated, the harmful effects of atomic plant emissions are being compared to that of plants operating on conventional fuel (even natural radioactivity is taken into account when calculating the emissions of such establishments, etc.) [3]. In some cases (in certain areas) the dose, resulting from nacural radioactivity at conventional fuel plants is comparable and can even exceed the dose from radioactive products emitted by AEP's [5].

However, in order to evaluate the prospects of developing nuclear energy, evaluations on a global scale--extending over countries and continents--are necessary.

The significance of general evaluations of radioactive aftereffects of nuclear energy development and the comparison of the harmful effects of using conventional fuel with the possible harmful effects of the industrial use of nuclear energy is therefore understandable.

The harmful effects of using conventional fuel are generally related to the emission of harmful substances which are formed during the combustion of the fuel. In the case of electric power plants and motors (those which use coal, fuel oil, and other petroleum products) these are basically sulfur dioxide and ashes, hydrocarbons, nitrous oxide, lead monoxide, etc.

In the last years, some 200-250 million tons of fuel ashes and various types of dust and approximately 60 million tons of sulfur dioxide have been emitted into the atmosphere world-wide. The amount of toxic substances in the air of several large cities significantly surpasses the maximum possible concentration (MPC) [6].

The emission of sulfur dioxide in the burning of coal presently in 160-2040 g per 1 ton of burned fuel. The amount of ashes (taking into account ash collectors) can exceed the specified amounts by several times [6]. According to the data in article [6] it is possible to write an approximation formula for the amount of sulfur gas a (ton per 24-hour period) emitted by an electric power plant into the atmosphere during the combustion of fuel oil:

$$a \approx 0.09 \rho \alpha \quad (1)$$

where

ρ = the capacity of the plant in MW
α = the amount of sulfur in the fuel oil, in percent

If we take as the average value = 2.5 percent, then the annual emission of sulfur dioxide by conventional fuel electric power plants, assuming equal emission per unit of power and burning liquid and hard fuels, is (at a total

capacity of 10^6 MW) approximately 80 million tons, and in the year 2000, it will make up (at a total capacity of 5.5×10^6 MW [2]) approximately 450 million tons of SO_2 and approximately 1.5 billion tons of ashes. Of course, this total can be somewhat decreased by the application of very expensive purification methods.

The possible harmful effects or danger in the use of nuclear energy is related to the formation of radioactive products as a result of fission or fusion as well as to possible induced radiation caused by the interaction of neutrons with the nuclei of the elements of the various surrounding construction.

At present we have accumulated much experience with the functioning of nuclear reactors (not less than 10^3 reactor-years of work) [3].

During the working of the atomic electric power plant the fission products gradually accumulate in the active zone of the reactor; the construction of present day plants effectively excludes the emission of such products into the environment in the course of normal reactor function [4] (the problem of radioactive waste is not considered in this work). During this process only an insignificant amount of gaseous isotopes Ar^{41}, C^{14}, H^3, Xe^{137} and traces of I^{131} can fall into the atmosphere. Therefore, according to [5], some atomic reactors in the U.S. release up to 650 Ki/24-hours of Ar^{41}. According to [7] the radiation dose even in the zone of the plant will not exceed 1 percent of the permissible.

It should be mentioned that in the process of dissolving spent fuel elements in radiochemical production, the emission of Kr^{85} (the only long-living inert gas) into the atmosphere is apparently unavoidable. In that case, we should assume a formation of 4.2×10^5 Ki of Kr^{85} at complete fission of 1 ton of U^{235} (approximately per 800 MW annual electric energy production per AEP).

In the event of an accident at an AEP, it is possible that iodine isotopes and several other relatively volatile isotopes can be released into the atmosphere. The biggest emission in the history of reactor construction took place during an accident at Windscale, was accompanied by the burning of the active zone and consisted of 2×10^4 Ki of I^{131}; 1.2×10^4 Ki of Te^{132}; 6×10^2 Ki of Cs 137; 80 Ki of Sr^{89} and 2 Ki of Sr^{90} [8].

According to the evaluation given in [9], the frequency of accidents on a reactor site is less than 10^{-2} per 1 reactor year. The probability of large emissions of I^{131} is exceedingly small. In the work [10] it is considered most probable that a large accident (accompanied by the emission of several thousand Ki of I^{131}) can happen once in 1000 years of reactor use. The curve which describes the possibility of the emission of another amount of I^{131} depending on the length of reactor use is described by the law $t^{0.6}$. The degree of danger--in a series of accidents--in the form of cancer of the thyroid gland in regions of great population density (up to 5000 people per km^2) is greatest during the emission of 10^3Ki of I^{131} and totals 3 cases [11].

The evaluation of radioactive conditions and the determination of danger (risk) in the use of atomic reactors can be made by taking into account experimental data in each individual case. The results of the calculations influence the selection of the site, the safety measures and the protective measures taken. In addition, in each case, the recommendations and standards (international or national) for the protection of the population against radioactivity should be considered, as well as the rational evaluation of the relationship between use and risk.

However, in the quick development of nuclear energy it is important to have a clear perception of the possibility of nuclear energy development keeping in mind the possible radioactive effects in the whole world as well as a prognosis of the global radioactive condition concerning all probable emissions when the developmental programs are actually put into effect. It is necessary to determine absolute amounts of radioactive products which are found in nature, the doses obtained from these products and to compare the possible effects of the given pollution with the effect of pollution by non-radioactive harmful substances.

In calculating the global radioactive condition in the development of nuclear energy we weill assume the following:

--by the year 2000 about 5×10^3 reactors with an average capacity of 10^3 MW each will be in use;

--the distribution of the reactors on the land masses will be more or less regular;

--the number of significant accidents with emissions of approximately 10^3 Ki of I^{131} is approximately 5 (one accident per 10^3 reactor-years), or smaller accidents with an emission of 10^2 Ki of I^{131}--about 30 per year.

Thus, depending on the age of the reactor, up to 5×10^3 Ki of I^{131}, 30-140 Ki of Cs^{137}, 4-7 Ki of Sr^{89} and 0.1-1.0 Ki of Sr^{90} will be released into the atmosphere in a year [8].

The isotopes mentioned above will for several days settle on the land masses (calculating the rate of effective settling equal to 0.1-1 cm/sec) and will not have managed to spread out over the globe. In the calculations it can also be assumed that all of these isotopes will settle either on dry land or in the zone of the crippled reactors (approximately 10^7 km^2 not considering possible overlapping.)

The most dangerous isotope in an accident (for respiratory ingression and ingression with milk) is I^{131}; the other isotopes represent a danger mainly as a source of external radiation (Cs^{137}) or by ingression with food or water (Sr^{89}, Sr^{90}). According to our calculations and the data in [8] the pollutants of the earth's surface which approach the limits of radiation doses for the population (per year) are: for Cs^{137}-1.0-2.0 Ki per km^2; for Sr^{90}-0.06-0.6 Ki/km^2, and for I^{131}-50 mKi/km^2 (for children).

During the functioning of the reactor, H^3 and C^{14} may enter the atmosphere. Tritium is formed in the reactor as a result of fission and neutron capture in deuterium and lithium 6 (approximately in equal quantities) and enters the atmosphere in quantities up to 10-30 Ki/MW annually [12].

In the dissolving of spent fuel, approximately 3 x 10^9 Ki of Kr^{85} per year can enter the atmosphere (according to the projected capacity levels of the AEP by the year 2000). Longliving tritium and Kr^{85} will mix equally in the lower layer of the earth's atmosphere. The dose of tritium is significantly less than that from Kr^{85} and consists of on the average 10^{-3} mR/year for the whole population by the year 2000.

The data for the various isotopes (most dangerous) averaged for local areas ($10^7 km^2$) is given in Table 1 in fractions of doses or permissible ingression for the population [14]. The data for Kr^{85} and H^3 are averaged on the basis of the whole earth.

ТАБЛИЦА 1. МАКСИМАЛЬНЫЕ ОСРЕДНЕННЫЕ ЗНАЧЕНИЯ КОНЦЕНТРАЦИЙ В ВОЗДУХЕ (ИЛИ УРОВНЕЙ ЗАГРЯЗНЕНИЯ) РАЗЛИЧНЫХ РАДИОАКТИВНЫХ И ТОКСИЧНЫХ ВЕЩЕСТВ ПРИ РАБОТЕ ОБЫЧНЫХ И ЯДЕРНЫХ ПРЕДПРИЯТИЙ (в долях предельных количеств: предела дозы, предельно допустимых поступлений для населения или предельно допустимых концентраций, – осредненных за год)

3) Изотопы и вещества	1) Атомные электростанции					2) Обычные электростанции	
	4) Обычная работа		5) Аварийная ситуация			SO_2	6) Летучая зола
	^3H	^{85}Kr	^{131}I	^{90}Sr	^{137}Cs		
7) На земной поверхности				10^{-4}	10^{-5}		
8) В воздухе	$5 \cdot 10^{-6}$	$3 \cdot 10^{-3}$	$7 \cdot 10^{-4}$			10	10
9) Максимальная величина для данного вида энергетики	$3 \cdot 10^{-3}$		$\sim 10^{-3}$				10

Table 1. Maximal Average Values of Atmospheric Concentrations (or Pollution Levels) of Various Radioactive and Toxic Substances During the Operation of Conventional and Nuclear Plants (in fractions of limit quantities: dose limits, population ingression limits or the limits of permissible concentrations - averaged for a year)

Key:

1. Atomic power plants
2. Conventional power plants
3. Isotopes and substances
4. Normal operation
5. Emergency situation
6. Volatile ash
7. On the earth's surface
8. In the atmosphere
9. Maximal value for the given type of energy

In the calculations we assumed that the distribution (intermixing) of the relatively short-lived isotope takes place in the lower 200-meter layer of the atmosphere. For the long-lived, Kr^{85} and H^3, we used the 500 meter layer

of intermixing, in view of their longevity in the atmosphere. In calculating the atmospheric pollution by conventional toxic substances we assumed their homogenous distribution also in a 200-meter lower layer of the atmosphere. Taking for SO_2 a life equal to 4 days [15] and the amount of expected emissions by the year 2000 to be 4.5×10^8 tons/year, we obtain that the air over the dry land will have on the average a constant ten-fold increase over the average daily allowable limit of 0.05 mg/m^3. Analogous figures are obtained for volatile ash. Close figures (in relation to MPC) are obtained in calculating the concentrations of other toxic substances.

The data given in Table 1 show that in the operation of conventional plants, 10^3–10^4 times more air is needed to dilute the toxic substances to acceptable levels than is required in the operation of atomic electric power plants (under the conditions described above). In addition, this relationship does not depend on the accepted height of the mixing layer as distinct from the values of exceeding permissible concentrations.

Although the limit levels of pollution for radioactive and non-radioactive toxic substances are based on somewhat different factors, nevertheless, we should keep in mind that emissions of toxic substances (radioactive and non-radioactive) can lead to direct harmful effects in part of the population as well as to genetic defects [16].

Let us also note that the use of atomic energy does not require the use of oxygen which is necessary for the combustion of conventional fuel, and it does not lead to a constant increase of CO_2 in the atmosphere.

Therefore, the conclusion can be drawn that the development of atomic energy ensures sufficient cleanliness of the environment. Moreover the substitution of atomic energy for energy obtained on the basis of conventional fuel will lead to a significant decrease in the pollution of the environment by toxic substances and will result in its eventual return to a healthier state.

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[317-9233]

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CSO: 8144/317

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JPRS 76189

7 August 1980

USSR Report

LIFE SCIENCES

BIOMEDICAL AND BEHAVIORAL SCIENCES

No. 3

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7 August 1980

USSR REPORT

LIFE SCIENCES

BIOMEDICAL AND BEHAVIORAL SCIENCES

No. 3

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UDC 615.339:576.858.095.383].015.4

BIOLOGICAL ACTIVITY OF A NEW SOVIET NATURAL INTERFERON INDUCTOR, DOUBLE-STRANDED RNA

Moscow ANTIBIOTIKI in Russian No 1, 1980 pp 28-32 manuscript received 4 Jul 79

FOMINA, A. N.: GRIGORYAN, S. S.: ZAYTSEVA, O. V.: NIKOLAYEVA, O. V: BUKATA, L. A.: NOSIK, N. N.: FADEYEVA, L. L.: and YERSHOV, F. I., Institute of Virology imeni D. I. Ivanovskiy, USSR Academy of Medical Sciences, Moscow

[Abstract] The tested double-stranded RNA (dsRNA) was supplied by the Institute of Microbiology imeni Kirshenshteyn by extraction from viruses and phages. White mongrel mice were given dsRNA at different times prior to infection with tick-borne encephalitis virus to determine the dynamics of interferon production. The animals developed hyporeactivity after 2 injections of dsRNA, associated with significant decline of blood serum interferon titers. Testing of different doses of inductor revealed that there is a correlation between protective effect and dosage (20 μg was ineffective, 50 μg lowered mortality by 20% and 100 μg by 40%), as well as between protective effect, route and time of administration of inductor prior to infection. In view of demonstration of marked interferon induction and immunostimulating activity, it is suggested dsRNA be further investigated as a promising antiviral agent. Figures 3; references 13: 3 Russian, 10 Western.
[222-10,657]

UDC 547.963.32.07

SYNTHESIS OF OLIGO- AND POLYNUCLEOTIDES. XXVIII. CHEMICAL AND ENZYMATIC SYNTHESIS AND CLONING OF AN ARTIFICIAL BRADYKININ GENE

Moscow BIOORGANICHESKAYA KHIMIYA in Russian No 12, 1979 pp 1802-1815

KOROBKO, V. G., DOBRYNIN, V. N., BOLDYREVA, YE. F., SEVERTSOVA, I. V., CHERNOV, B. K., and KOLOSOV, M. N., Institute of Bioorganic Chemistry imeni M. M. Shenyakin, Academy of Sciences USSR, Moscow, and GORODETSKIY, S. I., SLYUSARENKO, A. G., KAPELINSKAYA, T. V., LISENKOV, A. F., and DUBININ, N. P., Institute of General Genetics, Academy of Sciences USSR, Moscow

[Abstract] Chemical methods employed for the synthesis of the somatostatin gene (Itakura, K., et al., Science, 198: 1056, 1977) were used for the production of deoxyribonucleotide sequences corresponding to the bradykinin gene. A plasmid vector, designated as pL-1, for the bradykinin gene

was created from plasmic pBR 322 and a 4.4 megadalton fragment of phage lambda-plac5 DNA prepared by EcoRI treatment (which contained E. coli lac operon). Recombinant DNA was created between the pL-1 and bradykinin gene DNA and used for transformation of E. coli HB 101; subsequent isolation of a plasmid (pLB55) in which the bradykinin gene was joined to the distal portion of the lac z gene and was expressed under the control of the lac promoter and lac operator in the HB 101 cells led the production of a bradykinin-beta galactosidase chimera molecule. Bromocyanine cleavage of the latter resulted in release of bradykinin. Tables 2; Figures 8; References 32: 9 Russian, 13 Western.
[163-12172]

UDC 577.158.52+535.372

SPECTROFLUORIMETRIC STUDIES ON CONFORMATIONAL MOBILITY IN THE ACTIVE SITE OF HORSERADISH PEROXIDASE AND ITS RELATIONSHIP TO ENZYMATIC ACTIVITY

Moscow BIOORGANICHESKAYA KHIMIYA in Russian No 12, 1979 pp 1843-1853

SAVITSKIY, A. P., UGAROVA, N. N., and BEREZIN, I. V., Moscow States University imeni M. V. Lomonosov, Chair of Chemical Enzymology

[Abstract] In order to study the nature of horseradish peroxidase reaction with negatively charged substrates, use was made of a metal-free analogue consisting of protoporphyrin-apoperoxidase complex which is similar to the native protein in tertiary structure and fluoresces strongly in the red spectrum. Evaluation of the spectral changes in the pH range of 2-6 and the effects of interaction with I^-, $Fe(CN)_6^{4-}$, Cl^-, and Cs^+ led to the conclusion that there is considerable mobility of the protein fragments in the vicinity of the porphyrin molecule, i.e., at the active site. The increase in protein mobility with a decrease in pH is related to an increase in the electrostatic free energy of the protein. Most probably conformational mobility is affected by protonation of a number of carboxyl groups with pK values close to 4.5. Of particular importance is a group with a pK 4.3 to which the addition of a single proton markedly alters protein fluctuation so as to permit access of small molecules to the porphyrin moiety. This group appears to be one of the propionic acid residues on the porphyrin ring. Figures 5; Tables 3; References 30: 15 Russian, 15 Western.
[163-12172]

UDC 576.8.097.29.095.87

PROSPECTS FOR OBTAINING NONTOXIC BACTERIAL ENDOTOXINS

Moscow ANTIBIOTIKI in Russian No 1, 1980 pp 67-73 manuscript received 28 Feb 79

SHOSHIYEV, L. N.; AVRORov, V. P.; and YAGOVKIN, E. A., Rostov Plague Control Institute

[Abstract] There are at least three reasons for decontaminating bacterial endotoxins, generally referred to as lipopolysaccharides (LPS): endotoxins play a significant role in the pathogenesis of infections; possible use of nontoxic endotoxins for clinical and experimental studies; use of detoxified endotoxins for prevention of septic and hemorrhagic shock due to Gram-negative microorganisms. Among such products, pyrogenal and prodigiosan are already in use in clinical practice. Methods of decontaminating endotoxins are described and the most promising ones are evaluated (since the methods used to detoxify exotoxins are not effective for endotoxins): heating, irradiation, chemical and biochemical methods. It is also possible to obtain endotoxins with desired properties. Chemical methods that are considered to be promising include treatment with hydroxylamine, phthalate and succinate, as well as attenuation of detoxified LPS by conjugation with various carriers; promising biochemical methods involve the enzymatic approach. References 67: 21 Russian, 46 Western.
[222-10,657]

UDC 577.153.211.02

MICROCHROMATOGRAPHIC STUDIES ON ASSOCIATION RATE AND EQUILIBRIUM CONSTANTS OF PHOSPHOLIPASE A_2 ISOLATED FROM THE VENOM OF CENTRAL ASIAN COBRA

Moscow BIOORGANICHESKAYA KHIMIYA in Russian No 11, 1979 pp 1710-1719

MAL'TSEV, V. G., ZIMINA, T. M., KURENBIN, O. I., and BELEN'KIY, B. G., Institute of High Molecular Weight Compounds, USSR Academy of Sciences, Leningrad, and ALEKSANDROV, S. L., PAVLOVA, N. P., D'YAKOV, V. L., and ANTONOV, V. K., Institute of Bioorganic Chemistry imeni M. M. Shemyakin, USSR Academy of Sciences, Moscow

[Abstract] Elution patterns of phospholipase A_2 isolated from the venom of the Central Asian cobra (Naja naja oxiana) were studied in a microchromatographic system employing a 25 x 0.1 cm column packed with G-75 fine Sephadex in a pH 7.5 Tris-HCl buffer system to determine the kinetic and equilibrium constants of dimerization. The results showed that in the absence of Ca^{++} the equilibrium constant derived from the kinetic

data was 6 x 10^{-4} M^{-1}, while k_1 = 4.2 x 10^{-4} $M^{-1}sec^{-1}$, and k_2 = 0.7 x sec^{-1}. The presence of 0.02 M Ca^{++} did not affect the equilibrium constant but lowered the association and dissociation constants approximately four-fold, suggesting that Ca^{++} does not participate in stabilizing the active dimeric form of phospholipase A_2. Tables 2; Figures 8; References 27: 10 Russian, 17 Western.
[539-12172]

UDC 577.154.33

NEW ULTRASONIC METHOD FOR INVESTIGATING THE COMPOSITION AND PROPERTIES OF POLYENZYMATIC SYSTEMS: ENZYMES OF THE CELLULASE COMPLEX

Moscow BIOKHIMIYA in Russian No 1, 1980 pp 3-10 manuscript received 18 Jul 79

KLYESOV, A. A. and CHURILOVA, I. V., Chemistry Faculty, Moscow State University imeni M. V. Lomonosov

[Abstract] A new ultrasonic method for determining the composition and properties of discrete components of polyenzymatic systems without their prior separation described. The method is based on determining the pH dependence of the inactivation rate constants of the discrete components under the action of cavitational untrasound. The method was used to investigate the cellulase complex of the fungus Geotrichum candidum. It is shown that the composition of that complex includes at least four cellulolytic enzymes: endoglucanase exoglucanase, cellobiase, and aryl-beta-glucosidase. These enzymes display different values of the pK ionogenic groups determining the pH profiles of ultrasonic inactivation, as well as different inactivation rate constants of the active-center shape most resistant to the effect of the ultrasound. The inactivation of the enzymes by the ultrasound acting on their solutions occurs owing to the free radicals then forming in the solution. Thus the ultrasonic method of enzyme inactivation may be a useful complement to the known biochemical and kinetic methods for determining the composition and properties of polyenzymatic systems. Figures 2; references 26: 14 Russian, 12 Western.
[223-1386]

ELECTRON MICROSCOPE STUDY OF DENSONUCLEOSIS VIRUS MATURATION IN MOSQUITOES

Bratislava ACTA VIROLOGICA in Russian Vol 23, No 2, pp 170-172 manuscript received 12 Dec 78

BUCHATSKIY, L. P., and RAYKOVA, A. P., Kiev State University imeni T. G. Shevchenko

[Abstract] A study was made of electron microscope examination of densonucleosis virus maturation in infected larvae cells of blood-sucking mosquitoes A. aegypti L. Some 1st stage larvae of A. aegypti L. were inoculated by means of introducing a homogenate of infected densovirus 4th stage mosquito larvae at the rate of two per Petri dish. Preparations were examined with electron microscope "JDM-100B" at x 50,000, x 30,000 and x 20,000. The first ultrastructural changes in cells appeared 6-8 hours after infection, whereupon these changes were noted in nuclei as well as in cytoplasm. In cytoplasm, destruction was observed of endoplasmic reticulum and various organelles; also, paracrystalline inclusions appeared, consisting of round particles 18-20 nm. With development of the infection, the number of these increased, especially in the first three days. A large number of microtubes were observed between inclusions, observed also in other virus infections. Their diameter was 20 nm; according to Bykovskiy classification they could belong to type B. In hypertrophied nuclei the nucleoli could be divided into fibrillar and granular components, displaced toward the nuclear membrane. Mature virions appeared within virogenic stroma. The exit of virions apparently occurred as a result of cell breakage.
[249-12,152]

UDC 577.3

A POSSIBLE STAGE OF ABIOGENIC MOLECULAR EVOLUTION

Moscow BIOFIZIKA in Russian Vol 25, No 1, Jan/Feb 80 pp 7-12 manuscript received 15 Oct 74 revised 5 Apr 79

Ye. A. KAYMAKOV, Physical Technical Institute imeni A. F. Ioffe, USSR Academy of Sciences, Leningrad

[Abstract] Sublimation of relatively concentrated aqueous solutions leads to formation of porous matrixes composed of microcrystalline residues. Low concentration solutions produce threads during sublimation, probably through the development of spiral dislocations and cumulation of the solute molecules into monomeric sequences of considerable length. Each thread consists of an ice skeleton encapsuled in a molecular layer of the material being sublimed. Experiments in which the sublimation material was illuminated showed that along with sequencing of the molecules, they can

also polymerize, forming biological sublimation constructions - biosublicons. The study of biosublicons opens a new approach to finding the solution of the problem of the appearance of the first biological macromolecules on the planet earth. An individual polycomponent biosublicon consists of an ice skeleton wound with a spiral of interwoven chains of various biopolymers. The skeleton fixes spacial orientation of these chains and provides some stability against mechanical stresses. Formation of biosublicons on earth could have determined the initial genotype of all living things. Figures 4, references 21: 17 Russian, 4 Western.
[266-7813]

RESOLUTION OF THE CPSU CENTRAL COMMITTEE AND USSR COUNCIL OF MINISTERS "ON FURTHER DEVELOPMENT OF MEDICAL SCIENCE IN AREAS OF SIBERIA AND THE FAR EAST"

Moscow SOBRANIYE POSTANOVLENIY PRAVITEL'STVA SSSR in Russian No 23, 1979 pp 527-531

[Resolution No 778 dated 13 August 1979]

[Text] The CPSU Central Committee and the USSR Council of Ministers note that the solution of problems in the steady rise of the material and cultural level of life of the people, advanced by the Communist Party, and the securing of the right of citizens, assured by the new USSR Constitution, to preservation of health must be closely involved with improvement of the work of public health institutions, expansion of scientific research directed toward the prevention and reduction of the incidence of disease and lengthening of the active life of the Soviet people. The further development of medical science is acquiring especially great importance for Siberia and the Far East, where in accordance with the decisions of the 25th CPSU Congress enormous work is being developed on implementation of a program of complex organization of the natural resources of those areas, vitally important for our country.

During the years of Soviet power certain work has been done in those areas on the creation of a network of medical scientific research institutions and VUZ's and on the training of highly qualified cadres of medical scientists. At the present time scientific institutions and VUZ's of the USSR and RSFSR ministries and of the Siberian Department of the USSR Academy of Medical Sciences are engaged in working out questions of medical science here. The Siberian branches of the USSR Academy of Sciences and the All-Union Academy of Agricultural Sciences imeni V. I. Lenin (VASKhNIL) have been drawn in to solve medico-biological and socio-hygienic problems.

At the same time the CPSU Central Committee and the USSR Council of Ministers note that the development of the network of scientific medical institutions and the level and volume of medico-biological investigations in Siberia and the Far East still lag behind the growing needs of the public health service.

Many medical scientific research institutions, and also the Siberian branch of the USSR Academy of Medical Sciences have a weak material and technical base, are not completely staffed with highly qualified scientific personnel and do not participate actively enough in the solution of a number of medical problems, and especially the prophylaxis and therapy of cardiovascular, oncological and occupational diseases, and also of natural focal infections, preservation of the health of the mother and child, environmental hygiene and other questions connected with improvement of the medical care and preservation of the health of the population.

The USSR Ministry of Health and the USSR Academy of Medical Sciences have not adopted due measures to coordinate investigations being conducted by scientific research institutes and medical VUZ's, with consideration of the further intensive development of medical science in the eastern part of the country.

For the purposes of further development of medical science, expansion of scientific research work in the areas of theoretical and clinical medicine and the solution of very important socio-hygienic problems in areas of Siberia and the Far East, the CPSU Central Committee and the USSR Council of Ministers order:

1. The USSR Ministry of Health, the USSR Academy of Medical Sciences, the RSFSR Council of Ministers, kray and oblast committees of the Party and ispolkoms of kray and oblast councils of workers' deputies in Siberia and the Far East to implement a broad program of measures directed toward the further development of medical science. To assure the training of highly qualified scientific personnel for medical scientific research institutes and their rational distribution with consideration of the prospects of development of medical science and the public health service in eastern rayons.

2. Concentration of the efforts of collectives of scientific research institutions of the USSR Academy of Medical Sciences and the USSR and RSFSR ministries of health on all-possible development of basic and applied research on the leading problems of medicine, improvement of the effectiveness of the work of scientific research institutes, intensification of the coordination of their activity and strengthening of their relations with therapeutic and prophylactic institutions.

3. The USSR State Committee for Science and Technology, the USSR Academy of Sciences, the USSR Academy of Medical Sciences and the All-Union Academy of Agricultural Sciences imeni V. I. Lenin jointly with the USSR Ministry of Health and the RSFSR Council of Ministers:

--to prepare long-range plans of complex investigations on the study and further development of medico-biological, socio-hygienic and medical problems of Siberia and the Far East;

-- to carry out a broad program of scientific investigations of wild medicinal plants in order to more completely put the gigantic natural resources of Siberia and the Far East at the service of the health of man.

The RSFSR Council of Ministers to examine questions connected with the creation of special preserves for the conservation of the natural flora of those regions, and also with expansion of the network of farms and enterprises for the production of cultivated medicinal plants.

4. To adopt the proposal of the USSR Ministry of Health and the USSR Academy of Medical Sciences, agreed upon with the USSR State Committee for Science and Technology, the USSR Academy of Sciences and the RSFSR Council of Ministers, to transform the Siberian branch of the USSR Academy of Medical Sciences and its institutes into the Siberian department of the USSR Academy of Medical Sciences. To establish that the Siberian department of the USSR Academy of Medical Sciences be subordinate to the USSR Academy of Medical Sciences and the RSFSR Council of Ministers and be financed separately in the RSFSR budget.

The USSR Gosplan and the RSFSR Council of Ministers to examine the question of consolidating the material and technical base of the medical scientific research institutes and scientific subdivisions of medical VUZ's situated in Siberia and the Far East.

5. That the Siberian department of the USSR Academy of Medical Sciences accomplish the planning, coordination and forecasting of scientific investigations conducted by medical scientific institutions and medical VUZ's of Siberia and the Far East on the most important problems of medicine, and to prepare proposals on their inclusion in the state plan of economic and social development of the RSFSR.

6. The USSR State Committee for Science and Technology, jointly with the RSFSR Council of Ministers and the USSR Academy of Medical Sciences:

--to examine questions of the organization within the Siberian department of the USSR Academy of Medical Sciences of scientific research institutions for problems of pulmonology, surgery, endocrinology, medical genetics, immunology and biochemistry, and also of a branch of the All-Union Scientific Center of Cardiology of the USSR Academy of Medical Sciences;

--to take into consideration the decision of the USSR State Committee for Science and Technology regarding the creation in Tomsk of a branch of the Oncological Scientific Center of the USSR Academy of Medical Sciences;

--to examine in the established procedure the question of transfer of scientific research institutions to the Siberian department of the USSR Academy of Medical Sciences.

7. Adoption of the proposal of the USSR Ministry of Health and the USSR Academy of Medical Sciences, agreed upon with the USSR Gosplan and the RSFSR Council of Ministers, regarding the construction in the years 1981-1990 of the Institute of Physiology, a library and a medical school (Novosibirsk), the Institute of Medical Problems of the North (Krasnoyarsk), a laboratory

of Polar medicine (Noril'sk), the Institute of Complex Problems of Hygiene and Occupational Diseases (Novokuznetsk) and the Institute of Protection of Motherhood and Childhood (Khabarovsk) in accordance with the appendix [which does not accompany the resolution].

The USSR Gosplan to make provision, starting in 1980, in the drafts of state plans for the economic and social development of the USSR, for the allocation to the RSFSR Council of Ministers for the Siberian Department of the USSR Academy of Medical Sciences of the necessary capital investments and to determine the contracting and planning organizations to assure the planning and construction of the facilities indicated in the appendix.

The Krasnoyarsk and Khabarovsk kraykoms of the CPSU and krayispolkoms and the Kemerovsk and Novosibirsk obkoms of the CPSU and oblispolkoms to establish systematic control of the course of construction and the introduction into operation in the established periods of facilities of the Siberian department of the USSR Academy of Medical Sciences.

8. To improve the scientific and technical information about the development of medical science and the public health system in rayons of Siberia and the Far East to authorize the USSR Ministry of Health and the RSFSR Council of Ministers to organize, starting in 1981, the publication of the Bulletin of the Siberian Department of the USSR Academy of Medical Sciences with a volume of 42 printed sheets per year and a periodicity of publication of 6 times per year.

9. To adopt the proposal of the USSR Ministry of Health and the USSR Academy of Medical Sciences on increase of the number of vacancies of academicians of the USSR Academy of Medical Sciences by five and of corresponding members by 10 to fill up the staff of the Siberian department of the USSR Academy of Medical Sciences.

10. The USSR State Committee for Science and Technology, the USSR Gosplan and the USSR Ministry of Finance to increase for the RSFSR Council of Ministers for 1980 and following years the plan of financing of scientific research work, and also the wage fund and appropriates from the budget needed for the financing of the presidium of the Siberian department of the USSR Academy of Medical Sciences and new scientific research institutions that are being organized.

The CPSU Central Committee and the USSR Council of Ministers express confidence that the kray and oblast committees of the Party and the ispolkoms of kray and oblast councils of people's deputies, ministries and departments and the collectives of scientific medical institutions and medical VUZ's will undertake the necessary measures for the further development of medical science and elevation of the level of the public health service in rayons of Siberia and the Far East.

Secretary of the CPSU
Central Committee
L. Brezhnev

Chairman of the USSR
Council of Ministers
A. Kosygin

Moscow, the Kremlin, 13 August 1979, No 778
[178-2174]

METHODS FOR ASSAYING SOME RADIOACTIVE ISOTOPES AT THE LEVEL OF OR LESS THAN THE MEAN ANNUAL PERMISSIBLE CONCENTRATIONS IN LIQUID WASTE, ENVIRONMENTAL OBJECTS AND BIOLOGICAL SAMPLES

New York PEACEFUL USES OF ATOMIC ENERGY--Proceedings of the Fourth International Conference on the Peaceful Uses of Atomic Energy Jointly Sponsored by the United Nations and the International Atomic Energy Agency, and held in Geneva, 6-16 Sep 71 in Russian Vol 11, 1972 pp 641-662

[Article by Z. V. Yershova, V. K. Markov, N. Ye. Tsvetayeva, L. A. Ivanova, D. A. Fedoseyev, M. N. Yerofeyeva, N. A. Zemlyanukhina, V. P. Kermanov, M. M. Golutvina, N. Ya. Nov'kova and M. N. Kulichenko, USSR State Committee for the Use of Atomic Energy, Moscow, USSR]

[Text] Abstract

Appearance in the environment of artificial radioisotopes, in particular such as strontium 90, cesium 137 and plutonium 239, has made it necessary to implement routine monitoring of distribution thereof. This presents high requirements, with respect to rapidity and sensitivity of monitoring methods. This paper submits a brief survey of the known methods for quantitative assay of these radioisotopes. The new methods of assaying strontium 90 (according to yttrium 90), cerium 144 and cesium 137 in salt-free and salt-containing aqueous solutions proposed here are rapid and highly sensitive down to 0.1 of maximum permissible concentration. These techniques are based on a new and very effective principle for concentration of radioisotopes, in which liquid extraction is combined with coprecipitation. For this purpose, an organophosphorus compound is used as extractant--monoisooctyl ester of methyl phosphonic acid ($CH_3P\overset{O}{\underset{OH}{<}} - OC_8H_{17}$-i), which forms a solid organic phase in the presence of some cations--mixed organic salts in the form of flocculated deposits that can be readily separated from the aqueous solution. In this manner, the radiosotopes to be assayed can be virtually entirely (98-100%) extracted from large volumes of aqueous solutions (V_a = 1-20 ℓ) in small amounts of solid organic phase (V_o = 0.5 to 10 g, respectively), and no more than 30 min is required for this. It is also possible to assay these radioisotopes separately in the same sample.

There are two important advantages to the combination of liquid extraction and coprecipitation: in the first place, a rather high coefficient of distribution

with D ≈ 10 ; in the second place, a solid organic phase is formed that can be readily separated from the aqueous solution. Both this qualities make it possible to concentrate to a very high degree (by over 10^3 times) the radioisotopes with sufficient and selective extraction thereof. A prerequisite was formulated for extraction into the organic phase of ≥90% of the isotope under study and ≤9% interfering isotopes. The simplicity and speed of the proposed techniques make it possible to use them for regular monitoring of liquid waste from treatment plants, open bodies of water, underground water, atmospheric precipitations, etc., even under field conditions. The authors discuss the possibility of using these methods in the presence of macroimpurities, and they describe the conditions for analysis to assay ^{90}Sr, ^{144}Ce and ^{137}Cs in sea water, foodstuffs and various biological specimens (urine, bone tissue, lung tissue, teeth).

The assay of ^{90}Sr in biological objects is made satisfactorily even when the levels are below the maximum permissible concentration. The paper describes a method of assaying ^{239}Pu based in liquid extraction of monoisooctyl methylphosphonic acid and a mixture of isoamylphosphoric acids in a phase volume ratio of $v_a/v_o \leq 100$. This technique is used for assaying ^{239}Pu content of lung tissue, bone tissue, water in open reservoirs and other environmental objects.

Introduction

At the present time there is a need for regular monitoring of levels of the most hazardous radioisotopes (for example, ^{90}Sr, ^{137}Cs, ^{239}Pu and ^{144}Ce) in environmental objects and biological samples at radioactivity levels that are lower than the mean annual permissible concentrations (MPC) [1]. In most cases direct radiometric monitoring of such low concentrations of radioisotopes is impossible, so that selective preliminary concentration of the radioisotope under study is required.

Many works have been published in recent years proposing various methods of concentration of these radioisotopes [2-7]. Extraction techniques for concentration are widely known, for example, those using TBP [tributyl phosphate] [8, 9] and D2EGFK [should be H_2MEHP for mono-2-ethyl hexyl phosphoric acid] [10-13].

In this work, we propose new techniques for assaying low levels in aqueous solutions of ^{90}Sr (according to ^{90}Y), ^{144}Cs, ^{137}Cs and ^{239}Pu, which are based on concentration of these isotopes by means of extracting them from large volumes of solutions with small amounts of liquid extractants, which form extracts in the form of a readily separated solid phase, as well as by means of extraction of plutonium with a fine film of extractant fixed on the surface of a solid carrier.

Correlation Between Concentration, Extraction and Separation of Radioisotopes During Extraction

In the case of such a high degree of concentration, there is distinctive manifestation of a correlation between thoroughness, selectivity of extraction of radioisotopes and degree of concentration thereof.

Using the equation for balance of matter in extraction, $c_b v_a = c_o v_o + c_r v_a$,* we obtain the equation for evaluation of extent of extraction of a radioisotope into the organic phase, $q = c_o v_o / c_b v_a$:

$$q = \frac{1}{1+1/\delta} \tag{1}$$

In equation (1) δ refers to the following:ratio:

$$\delta = \frac{D}{v_a/v_o} \tag{2}$$

where D is the coefficient of distribution of the extracted radioisotope and v_a/v_o is the ratio between phase volumes.

According to equations (1) and (2), for virtually complete extraction of a radioisotope ($q \to 100\%$), the coefficient of its distribution must be significantly higher than the phase volume ratio:

$$D_I \gg \frac{v_a}{v_o} \tag{3}$$

From equations (1) and (2) we also obtain the condition for extracting as little as possible of any other radioisotopes present in the mixture along with the one to be concentrated:

$$D_{II} \ll \frac{v_a}{v_o} \tag{4}$$

where D_{II} is the coefficient of distribution of each of the interfering radioisotopes. By putting together inequalities (3) and (4), we obtain the condition for quantitative and selective extraction of a radioisotope into the organic phase:

$$D_I \gg \frac{v_a}{v_o} \gg D_{II} \tag{5}$$

or

$$\delta_I \gg 1 \gg \delta_{II} \tag{6}$$

where $\delta_I = \frac{D_I}{v_a/v_o}$; $\delta_{II} = \frac{D_{II}}{v_a/v_o}$.

*It is assumed that there is no change in volume v_a during the extraction process; subscript b refers to base, or initial value.

The need to meet condition (5) for separation of radioisotopes is evident from the examples obtained from estimated graphic extraction of radioisotopes with distribution coefficients D' = 10, D" = 10^3 and D"" = 10^5 as functions of phase volume ratio v_a/v_o (Figure 1).

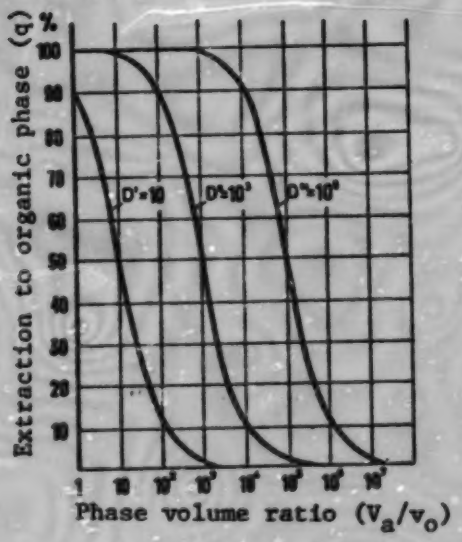

Figure 1.
Extraction of radioisotopes with different distribution coefficients as a function of phase volume ratio

As can be seen in Figure 1, in the case of $v_a/v_o = 1$, all radioisotopes with D>10 are extracted virtually completely into the organic phase: 91, 99 and 99.9%, respectively. In this case, condition (5) is not met, and it is impossible to separate the isotopes regardless of value of their separation coefficient (D_1/D_2).

Figure 1 also shows that separation becomes possible as soon as condition (5) is met, i.e., when the value of the phase volume ratio will be between the coefficients of distribution, for example, $D_I = 10^3$; $v_a/v_o = 10^2$; $D_{II} = 10$ or $D_I = 10^5$; $v_a/v_o = 10^2$; $D_{II} = 10$. The higher the separation coefficient, the deeper separation will be.

Thus, condition (5) shows the sequence of values of distribution coefficients and phase volume ratios required to separate isotopes, without defining the quantitative correlation between them.

In order to determine optimum conditions for separation of two radioisotopes, it is expedient to analyze the ratio of shares thereof changed to the organic phase as a function of D_I, D_{II} and v_a/v_o:

$$\frac{q_1}{q_{II}} = \frac{D_I}{D_{II}}\left(\frac{1 + \delta_{II}}{1 + \delta_1}\right) \qquad (7)$$

It is of the itmost importance here to determine the possibility of separation for quantitative extraction of one of them to the organic phase, and this will occur if $D_I \gg v_a/v_o$, and then equation (7) will acquire the following appearance:

$$\frac{q_I}{q_{II}} = \left[1 + \frac{1}{\delta_I}\left(\frac{D_I}{D_{II}}\right)\right]_{\delta \gg 1} \qquad (8)$$

or

$$\frac{q_I}{q_{II}} = \left[1 + \frac{1}{\delta_{II}}\right] \qquad (9)$$

Equation (8) is graphically illustrated in Figure 2, which shows that the possibility of separation is not unequivocally determined by the coefficient of separation, but that it is also related to the value of the coefficient of distribution and phase volume ratio.

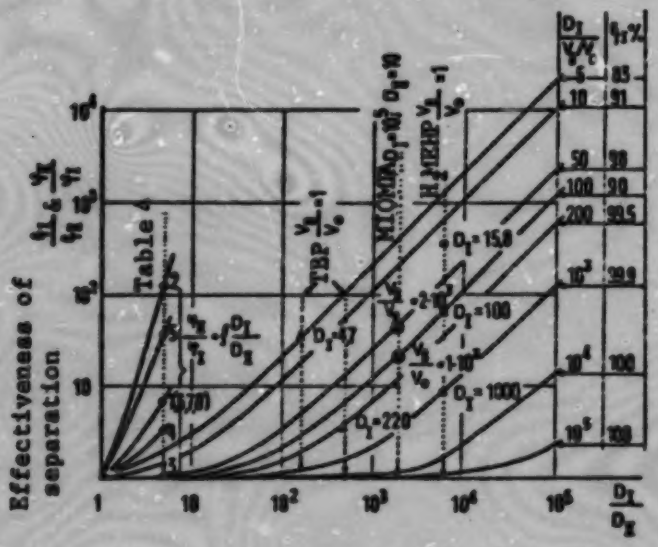

Figure 2. Effectiveness of separation of two components as a function of coefficient of separation D_I/D_{II} with different values for $D_I/(v_a/v_o)$

Key: V_B) volume of aqueous phase

New Principle of Concentration of Radioisotopes

The proposed methods are based on the use of a new organophosphorus compound, monoisooctyl methylphosphonic acid—MIOMPA ($CH_3P^{O}_{OH}OC_8H_{17}$-i), which was synthesized by Prof K. A. Petrov. The physical characteristics of MIOMPA are: $n_D^{20} = 1.4405$, M = 208, $\rho = 0.9462$, $t^{\circ}_{boil.} = 130°C$ at 10^{-6} mm Hg.

MIOMPA resembles the well-known extractant H_2MEHP in its extractive properties; the latter was proposed originally by Peppard et al. for separation of rare earth elements [10]. MIOMPA, like H_2MEHP, is an organic acid, which extracts well elements in the rare earth group, as well yttrium, forming an organic salt with them, a hard amorphous substances. MIOMPA is virtually ineffective in extracting elements of the first and second groups (see Table 1).

Table 1. Coefficients of distribution (D) and extraction (q) of some radioisotopes when extracted in trivalent iron MIOMPate from nitrate solutions of 0.4 N with a phase volume ratio of $v_a/v_o = 2 \cdot 10^3$

Radioisotope	q, %	D
^{90}Sr	$\leq 0{,}01$	$\ll 1$
^{137}Cs	$\leq 0{,}01$	$\ll 1$
^{45}Ca	$\leq 0{,}01$	$\ll 1$
^{65}Zn	$\leq 0{,}01$	$\ll 1$
^{140}Ba	$\leq 0{,}01$	$\ll 1$
^{14}C	$\sim 0{,}01$	$\ll 1$
^{60}Co	0,3	7
^{140}La	2	34
^{144}Ce III	3	70
^{147}Pm	15	302
^{131}J	23	602
$^{152-154}Eu$	30	860
^{59}Fe III	30	860
$^{95}(Zr\text{-}Nb)$	73	$5{,}5 \cdot 10^3$
^{46}Sc	89	$1{,}7 \cdot 10^4$
^{90}Y	≥ 98	$\geq 1 \cdot 10^5$
^{144}Ce IV	≥ 98	$\geq 1 \cdot 10^5$
^{239}Pu III	≥ 99	$\geq 1 \cdot 10^5$
^{239}Pu IV	≥ 99	$\geq 1 \cdot 10^5$
^{239}Pu VI	90	$1 \cdot 10^4$

MIOMPA forms a solid salt, trivalent irone MIOPate, with ions of trivalent iron over a wide range of acidity, from pH 6-7 to 4 N HNO_3 (HCl). It is known that there are also other organic acids that form solid organic salts with trivalent iron ions [5, 12, 14]. We obtained organic deposits from interaction of trivalent iron ions and H_2MEHP and isoamylpyrophosphoric acid. However, the formation of a deposit with H_2MEHP is possible only within a narrow range of acidity (pH = 2.0-2.5).

Trivalent iron MIOMPate has some very valuable properties, which open up vast possibilities for concentrating radioisotopes from very dilute aqueous solutions. Thus, there is an increase in extraction of radioisotopes into the organic phase with formation of the former, as a result of which there is a drastic increase in distribution coefficients (Table 2).

Table 2. Comparative extraction of some radioisotopes from aqueous solutions through liquid extraction with MIOMPA and extraction into the solid organic phase, MIOMPate of trivalent iron for $v_a/v_o = 10^3$

Radioisotope	(N)	Organic phase extraction, (%)			Distribution coefficient			Sorption on MIOMPate %
		Liquid extraction with MIOMPA, q_{liq}	Extraction in iron MIOMPate q_{eff}	Due to formation of solid deposit $q_{eff} - q_{liq}$	Liquid extraction D_{liq}	Extraction in iron MIOMPate D_{eff}	$\frac{D_{eff}}{D_{liq}}$	
^{91}Y	0,2	78	99	21	$1,6 \cdot 10^3$	$1 \cdot 10^5$	62	5
	0,3	43	99	36	$8,8 \cdot 10^2$	$1 \cdot 10^5$	116	2
	0,4	55	99	44	$6,0 \cdot 10^2$	$1 \cdot 10^5$	166	1
	0,6	22	98	76	$1,4 \cdot 10^2$	$5,0 \cdot 10^4$	345	0
	0,8	3	86	84	10	$6,0 \cdot 10^3$	600	0
	1,0	1	70	70	5	$2,0 \cdot 10^3$	500	0
Pu IV	0,2	89	100	11	$4 \cdot 10^3$	10^5	25	80
Pu III	0,2	93	100	7	$1 \cdot 10^4$	10^5	10	0
Pu IV	0,4	93	99	6	$1 \cdot 10^4$	$1 \cdot 10^5$	10	42
Pu III	0,4	94	99	5	$1 \cdot 10^4$	$1 \cdot 10^5$	10	5
Pu IV	1,0	84	39	5	$1 \cdot 10^4$	$1 \cdot 10^5$	10	70
Pu III	1,0	85	99	14	$3 \cdot 10^3$	$1 \cdot 10^5$	33	15
Pu IV	2,0	95	99	4	$1 \cdot 10^4$	$1 \cdot 10^5$	8	65
Pu III	2,0	75	99	24	$3 \cdot 10^3$	$1 \cdot 10^5$	50	40

The finely dispersed deposite of iron MIOMPate in the presence of a small amount of toluene acquires a large-grain structure and marked hydrophobic properties, for which reason phase separation occurs simultaneously with formation of the deposit, and no time is needed for settling as is the case with precipitating operations. For this reason, after mixing the solution for 20 min, the formed deposit can be immediately separated from the aqueous phase by filtration through gauze or other mesh filter. The separated deposit consists of a plastic [substance] from which it is easy to make a preparation of any configuration for measurement of both beta and gamma radiation.

High distribution coefficients combined with the simplicity of separation of the organic phase from the aqueous phase, and lack of need to allow the solution to settle are the elements that provide for a rapid method with quite high and selective concentration of radioisotopes. All this distinguishes the new concentration principle favorably from the methods for precipitation and liquid-liquid extraction in current use.

Extraction of Some Radioisotopes With Iron MIOMPate and Comparison to Liquid Extraction

We used trivalent iron MIOMPate to concentrate some radioisotopes for analytic purposes to assay small amounts (<MPC) of ^{90}Sr (according to ^{90}Y), ^{144}Ce and ^{239}Pu in aqueous solutions.

Extraction of the above radioisotopes with MIOMPate has definite advantages over liquid extraction, from the standpoint of feasibility of concentration of radioisotopes. This is related to the fact that, in the case of liquid extraction, separation of small volumes of the organic phase from large volumes of the aqueous phase is difficult and the phases are usually of comparable volume (v_a/v_o = 0.1÷10), while concentration with the use of iron MIOMPate is most often performed with a volume ratio of $v_a/v_o = 2 \cdot 10^3$ (see Figure 3).

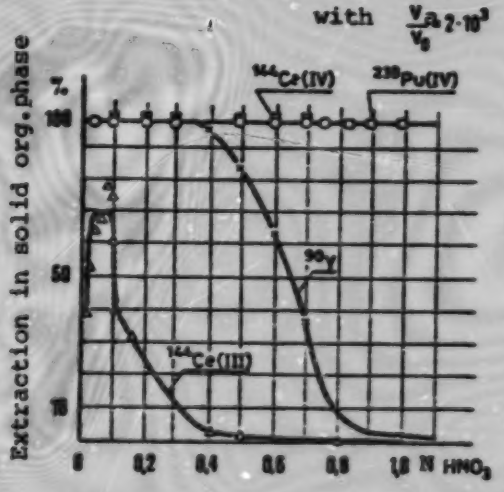

Figure 3.
Extraction of isotopes in solid organic phase as a function of concentration of nitric acid

Moreover, selectivity is a quite important feature in extraction of radioisotopes. Figure 4 illustrates the estimated curves of extraction of radioisotopes in theorganic phase as a function of coefficient of distribution (D) for $v_a/v_o = 1$, $2 \cdot 10^3$ and 10^4. The dots refer to experimental results of extraction of some radioisotopes. A comparison of the three curves shows that, with increase in phase volume ratio, there is a broader possibility of selective extraction. For a more specific evaluation of this possibility, we compared separation of yttrium and cerium using trivalent iron MIOMPate to the best results obtained with liquid extraction [10, 15] (see Table 3 and Figure 2). We see that with high phase volume ratios separation of these radioisotopes with MIOMPate compares well with separation using liquid extraction.

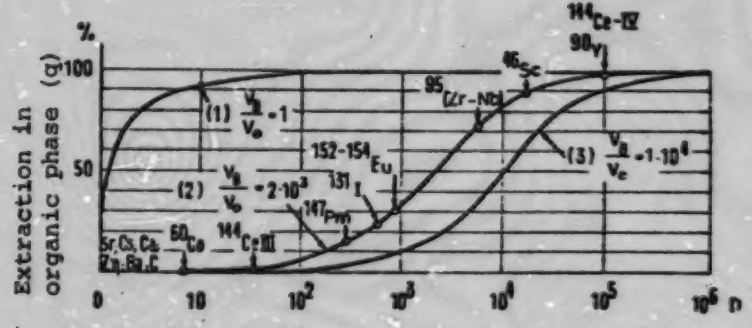

Figure 4. Extraction of isotopes into organic phase as a function of distribution coefficient, with different phase volume ratios

Key: V_B) aqueous phase volume

It should also be noted that the magnitude of the separation coefficient of yttrium and cerium (D_Y/D_{Ce}) does not determine the possibility of separating these radioisotopes, not only with extraction into the solid organic phase, but also with liquid extraction. This is particularly noticeable on the example of separation of yttrium and cerium using TBP for extraction [15], when the best separation corresponds to a lower separation coefficient (see Table 3 and Figure 2). An analogous inconsistency between magnitude of separation coefficient D_I/D_{II} and possibility of separation of two components is observed with liquid extraction in a stream [16]. In this case, separation of two components should be determined both by the relative content thereof after extraction in the raffinate, i.e., aqueous phase (ϕ_{II}/ϕ_I). According to the estimates, shown in Table 4, with an unchanged separation coefficient the actual separation of components can change over a wide range, depending on the magnitude of the ratio ($D_I(v_o/v_a)$). The submitted estimated data and experimental results indicate that separation depends not only on differences in distribution coefficients, but magnitude thereof, as well as phase volume ratio. Separation improves with equal phase volumes, as the coefficients of distribution or their equivalents ($\delta = D/(v_o/v_a)$) decrease. with differing

volumes. All this is valid when condition (5) is met. Otherwise, separation is impossible, regardless of degree of difference in distribution coefficients or magnitude thereof.

Extraction With Trivalent Iron MIOMPate--Combination of Liquid Extraction and Coprecipitation

As a result of combining two extraction processes, liquid extraction and coprecipitation, there is an increase in effectiveness of extraction of radioisotopes using iron MIOMPate, as compared to liquid extraction with MIOMPA. This ensues from the experimental data (see Table 2 and Figure 5), showing extraction of radioactive yttrium to the organic phase as a function of acidity of solution in the case of liquid extraction with MIOMPA and with MIOMPate. We see that a significant part of the yttrium is extracted from the aqueous solution during formation of the solid deposit, i.e., as a result of coprecipitation. This is associated with negligible sorption of this isotope. Evidently, coprecipitation occurs as a result of formation of polymer aggregates, in which the radioisotope, in this instance radioyttrium, is contained as a structural microcomponent.

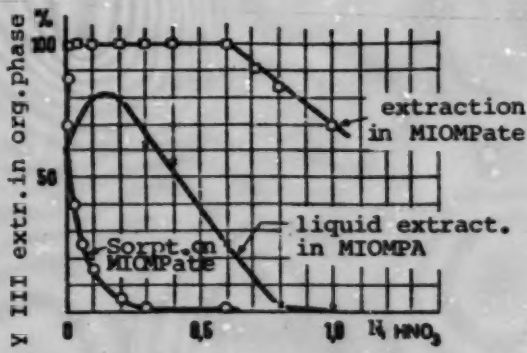

Figure 5.
Extraction of Y III as a function of concentration of nitric acid

In many cases, these two processes supplement one another when they occur simultaneously, providing for quantitative extraction of radioisotopes into the organic phase. This is observed with Pu IV over a wide range of acidity (Figure 6), Pu III with acidity of 0.1-0.2 N HNO_3 (Figure 7), Y III with 0.1÷0.3 N HNO_3 (Figure 5), as well as Ce IV.

However, in some cases, when running these processes simultaneously, there may be substantially less extraction of a radioisotope than when running liquid extraction followed by coprecipitation (Figure 7). Differences in radioisotope extraction in the case of separate and simultaneous use of reagents are also observed for Pu III and Pu IV, and for Ce III with low acidity (<0.1 N HNO_3)(Figures 6, 7 and Table 5). These results indicate that the radioisotope extraction process is depressed, under certain conditons, by the process of formation of iron MIOMPate.

Table 3. Comparative separation of yttrium and cerium III by extraction in trivalent iron MIOMPate and liquid extraction using H_2MEHP and TPB

Method of separation of yttrium and cerium III	D_Y	D_{Ce}	D_Y/D_{Ce}	V_a/V_o	q_Y,%	q_Y/q_{Ce}	Extraction conditions
Extraction in trivalent iron MIOMPate (authors' data)	10^6	70	1430	1	100	1	0,4 NHNO_3
	10^5	70	1430	10	100	1,15	
	10^4	70	1430	10^2	99	15,1	
	10^3	70	1430	10^3	91	131	
Liquid extraction with H_3MEHP [10]	15,8	0,0025	$6\cdot10^3$	1	94	350	0,5 N HCl | 0,75 M
	100	0,017	$6\cdot10^3$		99	60	0,3 N HCl | H_3MEHP in
	1000	0,17	$6\cdot10^3$		100	6	0,1 N HCl | toluene
Liquid extraction with TBP [15]	220	0,42	525	1	99,5	3,4	13N HCl; 100% TBP
	4,7	0,029	162	1	82,5	29	12,5 N HCl; 48% TBP in kerosene

Table 4. Estimate of effectiveness of separation by liquid extraction of two components (ϕ_{II}/ϕ_I) with distribution coefficients D_I and D_{II} as a function of $D_I(v_o/v_a)$ with unchanging separation coefficient D_I/D_{II}

Component distribution coefficient D_I	Component distribution coefficient D_{II}	$\frac{D_I}{D_{II}}$	$\frac{v_o}{v}$	$D_I\frac{v_o}{v}$	Postextract. component content in raffinate,%* ϕ_I	Postextract. component content in raffinate,%* ϕ_{II}	$\frac{\phi_{II}}{\phi_I}$	Comments
0,71	0,14	5,05	2,06	1,46	6,7	46,8	6,95	Example taken from [16], p 90
7,1	1,4	5,05	2,06	14,6	0,03	3,6	120	Proportionate increase in distribution coefficients
0,071	0,014	5,05	2,06	0,146	86,9	92,0	1,1	Proportionate decrease in coefficients D_I and D_{II}
0,71	0,14	5,05	3,0	0,237	10,3	34,4	3,3	Increased v_o/v_a ratio with same values of D_I and D_{II} as in the example from [16]
0,71	0,14	5,05	5,0	0,142	1,05	20,0	19	
1,46	0,29	5,05	1,0	1,46	6,7	46,8	7	Proportionate changes in distribution coefficients, while volume ratio changes so that $D_I\frac{v_o}{v_a}$ = constant
14,6	2,9	5,05	0,1	1,46	6,7	46,8	7	
0,485	0,0965	5,05	3,0	1,46	6,7	46,8	7	

*Initial levels of components I and II in aqueous phase are taken as 100% each.

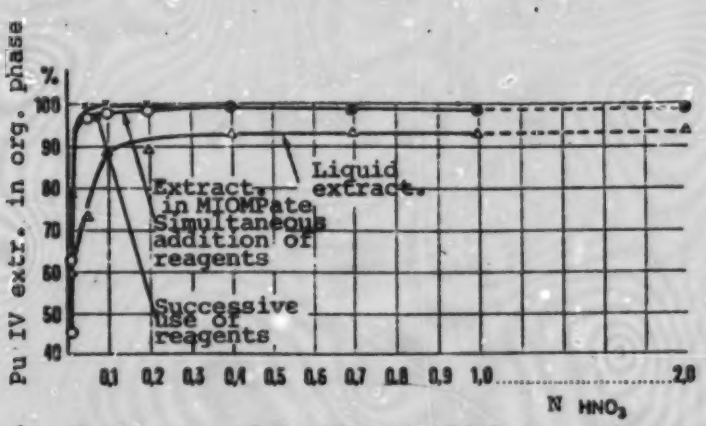

Figure 6. Extraction of Pu IV with MIOMPA as a function of concentration of nitric acid

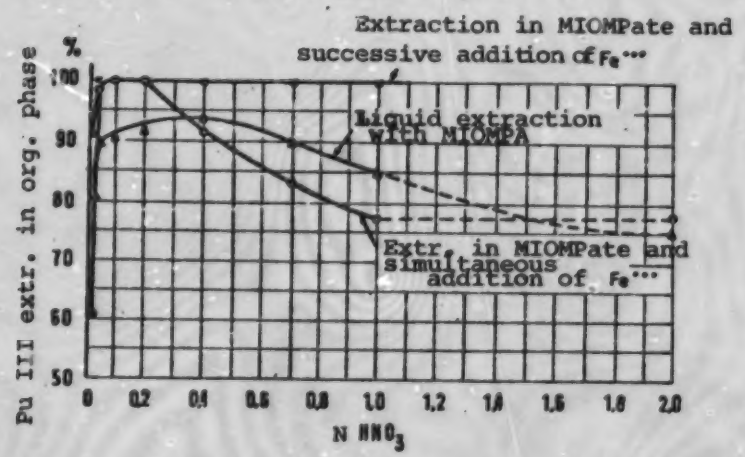

Figure 7. Extraction of Pu III with MIOMPA as a function of concentration of nitric acid

There is a combination of liquid extraction with MIOMPA and coprecipitation with trivalent iron MIOMPate in extraction of all radioisotopes, with the exception of radiocesium. In the latter case, extraction occurs as a result of complex coprecipitation with mixed ferrocyanide MIOMPate of iron and potassium (Figure 8). In all likelihood, this process is a combination of two precipitating processes. Ions of trivalent iron interact with potassium ferrocyanide, on the one hand, and with MIOMPA/HR/, on the other. As a result, an insoluble multinuclear complex is formed, perhaps:

Table 5. Comparative results of extracting some radioisotopes with concurrent introduction of organic phase and ions of trivalent iron, and with separate addition and mixing thereof with the solution

Isotope	Acidity of solution, N HNO_3	Extraction in trivalent iron MIOMPate, %				Due to coprecipitation $q_c = q_1 - q_{liq}'$
		successive addition of reagents q_1	simultaneous addition q_2	by liquid extraction: successive addition q_{liq}	by liquid extraction: simultan. addition q_{liq}	
Pu IV	0,01	78	45	61	28	17
Pu III	0,01	91	62	81	52	10
Pu III	0,7	99	84	90	75	9
Pu III	1,0	99	78	85	63	15
Ce III	0,05÷0,075	80	30	-	-	<30

which coprecipitates radiocesium.

Practical Use of the Proposed Concentration Method for Assaying Radioisotopes

Methods for assaying ^{90}Sr (according to ^{90}Y), ^{137}Cs, ^{144}Ce and ^{239}Pu in various environmental objects and biological samples were developed on the basis of the new principle of concentration. The sensitivity of these methods is attributable to the high degree of radioisotope concentration, which reaches $10^3 \div 10^4$ (see Table 6). The coefficient of variation is in the range of 10-20% in the different methods. Selectivity can be increased by removing impurities from the samples by means of preextraction. This is used in isolating ^{90}Y, ^{144}Ce and ^{137}Cs from a complex isotope mixture. In the case of ^{90}(Sr-Y), the sample is allowed to stand for a certain time prior to the main extraction.

"Stepped" extraction is also used to increase sensitivity, for example, to assay ^{90}Sr in the presence of large amounts of ^{106}Ru. This procedure is based on breakdown of the primary solid extract with alkali, with isolation of radioisotopes on iron hydroxide and repeated extraction of the analyzed isotopes from a nitric solution, which is obtained after dissolution of hydroxide.

The proposed methods make it possible to use the same sample for assays of several radioisotopes. Figure 9 and Table 7 illustrate one of the possible schemes for such an assay.

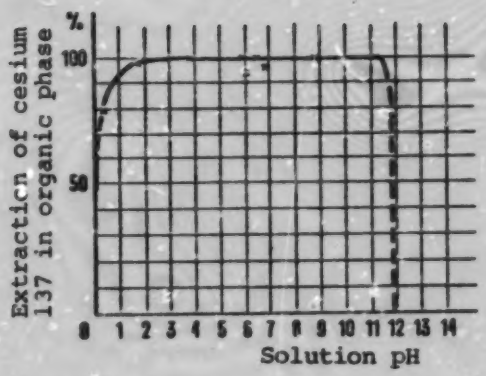

Figure 8.
Extraction of Cs into organic phase--ferrocyanide MIOMPate, as a function of solution pH

Table 6. Characteristics of extraction of radioisotopes from aqueous solutions using MIOMPA

Radioisotope	Acidity range N HNO_3	Extraction to organic phase		Degree of concentration, V_a/V_o	Time of concentr. min	Sensitivity of method, Ci/ℓ
		solid (%)	liquid (%)			
^{90}Y	0,01 ÷ 0,4	98 ± 1	80 ÷ 80	$2 \cdot 10^3$	20	$5,0 \cdot 10^{-12}$
^{144}Ce	0,01 ÷ 1,0	98 ± 1	80	$2 \cdot 10^3$	30	$1,0 \cdot 10^{-10}$
^{137}Cs	pH 2 ÷ 10	95 ± 5	0,1	$5 \cdot 10^2 \div 10^3$	10 ÷ 15	$1,0 \cdot 10^{-10}$
^{239}Pu	0,05 ÷ 2,0	95 ÷ 100	80 ÷ 95	$2 \cdot 10^3$	30	$1,0 \cdot 10^{-11}$

All of the methods were tested, and they have found application for analysis of natural and waste waters, atmospheric precipitations, soil, vegetation, foodstuffs, bone tissue and biological substrates.

Preparation of all types of samples for analysis amounts to obtaining nitrate solutions (0.01-0.4 N) in volumes of 0.1 to 10 ℓ, from which the isotopes in question are extracted using MIOMPA. For this purpose, ions of trivalent iron (20-100 mg/ℓ) are added to the solution, as well as the appropriate additives, depending on the nature of the radioisotope in question (see Figure 9 and Table 7). The order of procedures is illustrated in Figure 10. The salt composition of the samples does not have an appreciable effect on extraction, if it is represented by groups I and II cations and strong acid anions.

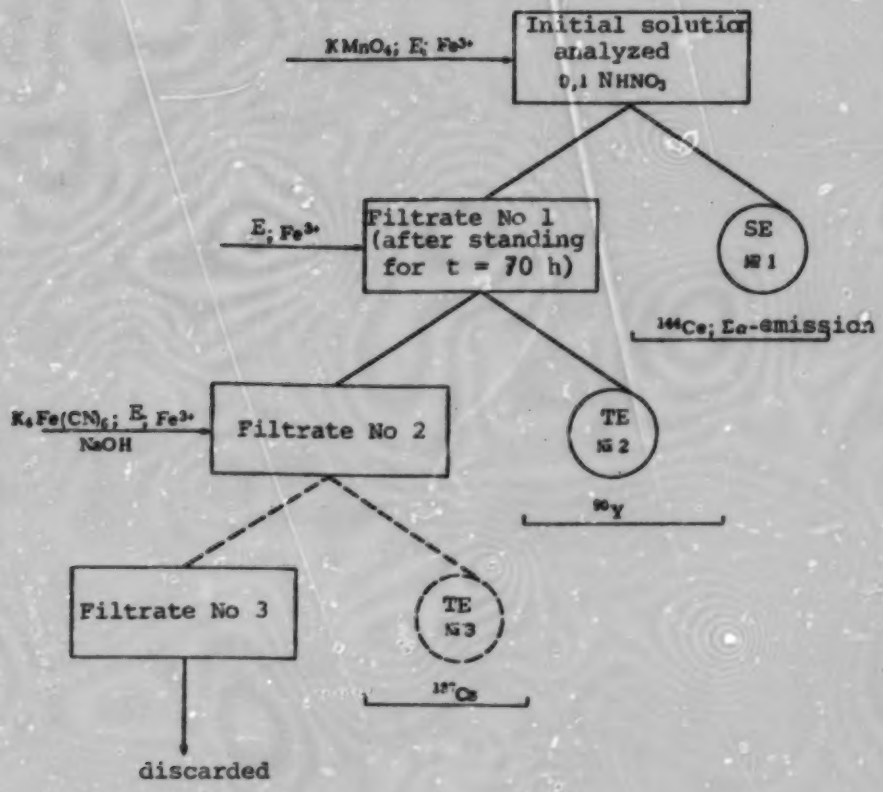

Figure 9. Diagram of analysis of radioisotopes in one sample (see Table 7)

Key:

E) solution (MIOMPA + toluene + kerosene)

SE) solid extract

t = 70h) time filtrate No 1 allowed to stand, due to need to accumulate ~50% of equiponderant ^{90}Y

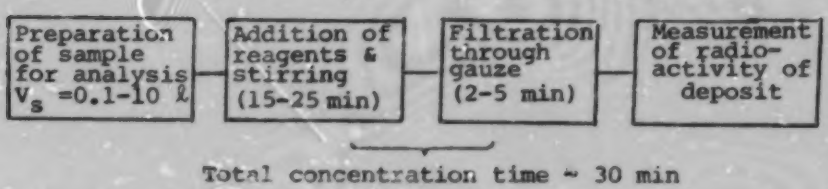
Preparation of sample for analysis Vs =0.1-10 ℓ
Addition of reagents & stirring (15-25 min)
Filtration through gauze (2-5 min)
Measurement of radio-activity of deposit
Total concentration time ~ 30 min

Figure 10. Order of procedure for analysis radioisotopes [V_s refers to sample volume]

Table 7. Amounts of reagents added per 5 ℓ solution when extracting radioisotopes from one sample[1] for analysis

Solution	Extractant & solvents,E			Fe^{3+} mg	$KMnO_4$ mg	$K_4[Fe(CN)_6]$ mg	HNO_3 N	NaOH mg	Radioisotopes assayed
	MIOMPA mℓ	toluene mℓ	kero-sene mℓ						
Initial solution	0	2.5	0.5	100	100	-	0.1	-	Σα-emitter[2] & ^{144}Ce
Filtrate No 1	3	2.5	-	100	-	-	-	-	^{90}Sr(according to ^{90}Y)[3]
Filtrate No 2	1	0	1.5	450	-	100	-	300	^{137}Cs[4]

[1] See Figure 9.
[2] Plutonium 239 is concentrated together with uranium and other actinides.
[3] For assay of ^{90}Sr (according to ^{90}Y) without preliminary extractions, the following are added: 5 mℓ MIOMPA, 3 mℓ toluene and 100 mg Fe^{3+}.
[4] Concentration of ^{137}Cs without preliminary extractions differs only in that alkali are not added to the analyzed solution.

The activity of solid extracts is measured according to beta emission using an end-window counter with low background; gamma radiation is measured on a scintillation spectrometer and alpha radiation on a scintillation counter.

However, measurement of alpha radiation of solid extracts involves some difficulties. The effectiveness of counting when measuring the deposit by the "thick layer" method is not great (<10%). Breakdown of the iron MIOMPate deposit with alkali to isolate plutonium makes the analysis more complicated. For this reason, liquid extraction is also used to concentrate plutonium in the methods of assaying Pu in environmental objects and biological samples. MIOMPA and isoamylpyrophosphoric acid (IAPPA) in toluene ($[H_2(i\text{-}C_5H_{11})_2P_2O_7$) are used as extractants. The values of D for Pu III and Pu IV are in the range of 500-2000 with 0.5-1.0 m/ℓ concentration of IAPPA in toluene and 0.1-8.0 m/ℓ nitric and hydrochloride acids. This makes it possible to quantitatively extract plutonium to the organic phase with volume ratios v_a/v_o = 50÷100. Plutonium is isolated from the organic phase on a deposite of nickel hydroxide in an alcohol medium or by re-extraction with ammonia oxalate solution. It should be borne in mind that other elements will also be extracted along with plutonium, i.e., alpha emitters such as uranium, americium and neptunium. The obtained concentrate of alpha emitters can be separated into components, if necessary, by means of other methods, for example, partition chromatography with facing [exposed?] phases.

Selective Extraction of Plutonium by Means of Partition Chromatography Columns With Facing Phases

The sorbing layer of the partition chromatography columns with facing phases consists of a ground solid carrier with hydrophobic surface, on which is applied a thin film of liquid organic extractant, virtually insoluble in water.

Upon filtration through such a column of aqueous solutions containing substances that are extractable with a given extractant, these substances are retained in the column.

The efficiency of extraction and separation in such columns is many times greater than ordinary liquid extraction, since extraction in the columns takes place under chromatographic conditions that provide for counterflow during the repeated acts of sorption and desorption of substances as the solution thereof moves in the layer of sorbent. There are many studies that were conducted with the use of this method, and they are described in surveys [17, 18].

The theoretical bases of the method of chromatographic extraction, which were developed by V. K. Markov and his colleagues, are described in detail in [19]. To extract plutonium from complex solutions, the authors of the cited work proposed a column consisting of ground shavings (or grit) of fluoroplastic, on the surface of which a film of trioctylamine (TOA) is applied.

It was found that the isotherm of distribution of tetravalent plutonium in TOA and nitric acid solutions can be described by the equation of Langmuir:

$$C_e = \frac{ABC}{1+BC} \qquad (10)$$

where C_e and C are equilibrated concentrations of Pu IV in the extractant and aqueous solution, respectively, A is maximum concentration of Pu IV in the extractant in the case of complete saturation, $B = [C_e]/[A-C][C]$ is the constant of extraction equilibrium. In the range of equilibrated [equiponderant] concentrations of Pu IV from 1 to 50 $\mu g \cdot m\ell^{-1}$, the values of the constants in equation (10) were found to be the same:

$$A \approx 98{,}000\ \mu g \cdot m\ell^{-1};\ B = 0.203$$

Dynamic activity (W) of the column, expressed as the volume of solution filtered through it up to the time that the extracted substance passes into the filtrate, should theoretically be described by the following equation, due to the convex shape of the distribution isotherm:

$$W = mD + v \qquad (11)$$

where D is the distribution coefficient corresponding to the concentration (C_0) of extracted substance in the initial solution $D = (A+B^0)/(1+BC_0)$, m is the volume of extractant in the column, in mℓ, and v is the intergranular space in the column, mℓ.

Using equation (11) and disregarding the presence of some diffusion of the actual front of substance moving along the column (theoretically it should be broken), one can calculate the approximate volume of extractant (m) required to extract substances from a specified volume of aqueous solution. Thus, with the specified values of W = 10 mℓ, $C_0 = 1 \cdot 10^{-3}$ μg/mℓ and

v = 0.2 mℓ, the volume of extractant is m ≈ $5 \cdot 10^{-4}$ mℓ. More precise calculation of m, with consideration of diffuse nature of the front is given in [19].

The high distribution coefficients of plutonium make it possible to extract it with infinitesimal volumes of TOA, which form a very thin film on the surface of the carrier.

This facilitates subsequent elution of plutonium from the column, which may be slower with thick films due to the slowness of diffusion processes in them.

It is significant that a change in concentration of nitric acid in the tested range from 1 to 4 N and zirconium nitrate content of up to 500 $mg \cdot \ell^{-1}$ do not have an appreciable effect on extractability of plutonium with TOA film.

Beryllium, aluminum and iron nitrates, when present in amounts of 50 $g \cdot \ell^{-1}$ in a nitric acid solution and presence of 200 $g \cdot \ell^{-1}$ sodium enhance the effectiveness of extraction.

In a concentration of 50 $g \cdot \ell^{-1}$, uranyl nitrate diminishes significantly the capacity of TOA for plutonium (IV).

The ease with which uranium in hexavalent state, americium and curium in trivalent state are retained in nitric acid solutions provides for highly effective separation of hexavalent plutonium from them. It is more difficult to separate plutonium from neptunium by this method; however, A. V. Yablochkin found conditions that provide for virtually complete separation of plutonium from this element as well. To an aliquot of solution he adds 1 M iron sulfaminate (II) to a concentration of 0.1 M and it is stirred. After about 1 min, 0.2 mℓ saturated $KBrO_3$ solution in 1.5 N HNO_3 is added per mℓ. After 20 min, the sample prepared in this manner is quantitatively transferred to a microcolumn, the walls of the beaker are rinsed in 1.5 N HNO_3, the solution is filtered thorugh the column then eluated in 3 mℓ 1.5 N HNO_3. The plutonium sorbed by the TOA film is eluated in 1 mℓ 3% ammonia oxalate in 1.5 N HNO_3, and this eluate is applied to a planchette of stainless steel to measure alpha activity. As an illustration, we submit the results of repeated analysis of two artificially prepared solutions with different concentrations of plutonium in them.

The components were present in solution in the following concentrations: 1.5 N HNO_3, 40 g/ℓ Al, 4 g/ℓ U, 35 mg/ℓ Np, 174 μg/ℓ and 1.61 μg/ℓ Pu.

The chromatography column, 3 mm in diameter, contained 0.1 g ground fluoroplastic-4 and 0.001 mℓ TOA on its surface.

On the basis of the obtained statistical data, it was found that the coefficients of variation constituted 4% and 7% in assaying concentrations of plutonium of 174 μg/ℓ and 1.61 μg/ℓ, respectively. The time required to isolate plutonium from the solutions and to assay it does not exceed 60 min.

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[0314-10,657]

10,657
CSO: 8144/0314

UDC 615.849.1.015.25.099

TOXICITY OF SINGLE AND MULTIPLE INJECTIONS OF CERTAIN RADIOPROTECTIVE PHOSPHORUS-CONTAINING DERIVATIVES OF ISOTHIOURONIUM

Moscow FARMAKOLOGIYA I TOKSIKOLOGIYA in Russian No 2, 1980 pp 212-215

ZAV'YALOV, Yu. V., and YAKOVLEVA, N. D., Laboratory of Radiation Pharmacology and Experimental Pathomorphology, Institute of Medical Radiology, Academy of Medical Sciences USSR, Obninsk

[Abstract] Studies were conducted on the relative toxicities of the ethylphosphate, diethylphosphate, and metaphosphate derivatives of S-ethylisothiouronium in female mice and Wistar rats. The LD_{50} values for these compounds in mice on intraperitoneal, subcutaneous, and intramuscular injection ranged from 455 to 772 mg/kg, while on intragastric administration the range was from 2100 to 2490 mg/kg. On intraperitoneal administration these agents were more toxic for the rats (LD_{50} = 113 to 425 mg/kg) than for the mice (LD_{50} = 455-510 mg/kg). Daily intramuscular administration of these radioprotective for 10 days (0.2 mM/kg/day) did not affect the behvaior of the animals or have any pathoanatomic sequelae. Figures 3; References 12: 4 Western, 8 Russian.
[301-12172]

UDC 576.312.33:577.39:599.8

COMPARATIVE STUDY OF RADIOSENSITIVITY OF MONKEY CHROMOSOMES UNDER IN VIVO AND IN VITRO IRRADIATION OF CELLS

Moscow GENETIKA in Russian Vol 15, No 9, 1979 pp 1661-1693 manuscript received 23 Oct 78 after revision of 7 Aug 78 version

DZHEMILEV, Z. A., Institute of Experimental Pathology and Therapy, USSR Academy of Medical Sciences, Sukhumi

[Abstract] Stressing the eminent usefulness of cytogenetic studies on monkeys as models for insight into related human problems, the need is cited for in vivo studies on chromosome radiosensitivity to support extrapolation of such studies to man. The present work was designed as a comparative analysis of the frequency of chromosome aberration in Macaca mulatta monkeys under irradiation of their somatic cells in vivo and in vitro. Males, 7-12 yrs, were used in these experiments; cells studied were peripheral blood lymphocytes and renal epithelial cells. In the in vivo tests the animals were subjected to 100 r gamma radiation; for in vitro tests blood was taken--prior to the in vivo irradiation--for irradiation of the lymphocytes. For the in vitro renal cell irradiation, same dose, cell cultures were used from other monkeys. Conditions of

radiation were the same for both in vivo and in vitro irradiation. Analysis for chromosome aberration followed Dzhemilev's procedure described earlier (1970, 1976, 1977). Results indicated essentially no differences in aberration yield in these cells under in vivo or in vitro exposure. References 8: 4 Russian, 4 Western.
[18-8586]

UDC 575.23:576.312.33:599.8

FREQUENCY OF RADIATION-INDUCED EXCHANGES IN READILY IDENTIFIABLE CHROMOSOMES IN MONKEYS

Kiev TSITOLOGIYA I GENETIKA in Russian No 6, 1979 pp 435-437 manuscript received 8 Aug 78

DZHEMILEV, Z. A., Institute of Experimental Pathology and Therapy, USSR Academy of Medical Sciences, Sukhumi

[Abstract] Chromosome aberrations in homologous pairs 1, 2, 3, 4, 8, 9 and 20, involved in formation of dicentrics, were determined in primary cell cultures of adult Macaca mulatta and Papio hamadryas kidneys irradiated in vitro at G_0 with 200 R. No significant species-related differences in radiosensitivity were found. M. mulatta cells contained 197 dicentric chromosomes and P. hamadryas cells 167. The frequency of involvement of chromosomes 1, 2, 3, 4, 8, 9 and 20 in asymmetric exchange was proportional to their length. Thus, the frequency of radiation-induced exchanges was proportional to genome size. Chromosome 1, which has less chromatin than chromosome 2, was involved twice as often in exchanges as chromosome 2, which does not suggest preferential localization of radiation-induced damage in heterochromatic regions. References 7: 7 Russian.
[135-9307]

UDC 575.111:576.312.36:599.824

TETRAPLOIDY IN EPITHELIAL KIDNEY CELLS IN MONKEYS EXPOSED IN VIVO AND IN VITRO TO DIFFERENT RADIATION DOSES: PART III

Kiev TSITOLOGIYA I GENETIKA in Russian No 6, 1979 pp 446-451 manuscript received 15 Aug 78

MACHAVARIANI, M. G., Institute of Experimental Pathology and Therapy, USSR Academy of Medical Sciences, Sukhumi

[Abstract] Epithelian kidney cell cultures from Macaca mulatta were irradiated in vitro at G_0 once in doses of 25, 50, 100, 200 and 400 R. Monkeys (1-3-years old) were irradiated in vivo with 620-660 R

(^{60}Co, gamma unit); cell cultures were obtained from these 0.5, 2 and 10 months after irradiation. Only tetraploid cells with 80-84 chromosomes were studied. In the 3-day culture, there was an increase in the number of tetraploid cells from 3.0% (25 R in vitro) to 5.1% (200 R) in comparison with the 0.8% control value. In the 5-day cultures (25-200 R), the number of tetraploids tended to increase to 8.4%, perhaps owing to culture senescence, as well as radiation. In vivo irradiation caused a significant increase in simple and complex (endoreduplicants) (EDR) tetraploid cells to 11.1% (0.9% in control) after 10 months. EDR cells comprised about 4.2-6.4% and simple tetraploids 1.8-1.9% 0.5-2 months after in vivo irradiation. After 10 months, there were 7.5% simple tetraploids and EDR cells decreased to 3.3%, which demonstrates the elimination of the most radiation-damaged cells. The data on radiation damage in monkeys, a model most similar to humans, may be used to supplement the WHO recommendations on biological dosimetry based on lymphocyte tetraploidy, since the radiosensitivity of the monkey kidney cells and peripheral plood lymphocytes was found to be similar. Figures 2; references 19: 1 Czech, 14 Russian, 4 Western.
[135-9307]

UDC 616-001.34:534.321.8]-057-092

EARLY REACTION OF THE ORGANISM TO LOW FREQUENCY ACOUSTICAL OSCILLATIONS

Moscow GIGYENA TRUDA I PROFESSIONAL'NYYE ZABOLEVANIYA in Russian No 10, Oct 79 pp 16-19 manuscript received 13 Feb 78

KARPOVA, N. I., ALEKSEYEV, S. V., YEROKHIN, V. N., KADYSKINA, YE. N., REUTOV, O. V., Leningrad Sanitary-Hygienic Medical Institute

[Abstract] The authors' institute is engaged in a project involving gathering of data on sources of infrasound, determination of the nature of its action on the organism and determination of the mechanism of the changes observed in the organism under the infulence of infrasound oscillations. This article involves determination of the very earliest reactions of the organism to this production factor. Studies were performed by modeling production infrasound parameters in an experimental acoustical complex. The experiments were performed on healthy male volunteers 19 to 29 years of age and also on rats, rabbits and guinea pigs. Sound frequencies used were 5 and 10 Hz, sound pressures 100 and 135 dB, exposure time 15 minutes. Within the first minutes, mental stress, autonomic reactions and unpleasant auditory sensations were noted, as well as feeling of general fatigue, weakness and pressure in the ears. Some 15 to 20% of the human subjects developed such symptoms as headache and dizziness. More than half complained of confusion, sleepiness and feeling of depression. Some felt vibration of the internal organs. The use of EEG, EKG, seismocardiography, pneumocardiography and audiometry

indicates that infrasound primarily causes disorders of the mechanisms of central regulation of the cardiovascular and respiratory systems, and disrupts protein synthesis and metabolic processes in the organism. References 8: 5 Russian, 3 Western.
[558-6508]

UDC 616-001.34-057.036.8

DYNAMICS OF VIBRATION DISEASE AFTER CESSATION OF CONTACT WITH VIBRATION

Moscow GIGYENA TRUDA I PROFESSIONAL'NYYE ZABOLEVANIYA in Russian No 10, Oct 79 pp 40-41 manuscript received 26 Jan 79

CHAGELISHVILI, A. D., LABADZE, P. F., TOGONIDZE, T. V., KHAVTASI, A. A., KAKULIYA, T. A., Tbilisi Institute of Labor Hygiene and Occupational Diseases

[Abstract] Dynamic observations were performed on 158 patients with vibration disease over a period of 5 years (1972-1976). The subjects were mostly males 30 to 49 years of age, who had worked for 11 years or more under conditions of exposure to vibration. Capillary spasm was observed in all patients, as well as vibration sensitivity and elongation of the time of the cold test. In spite of active combined therapy, complete rehabilitation was not observed over the period of 5 years; partial rehabilitation was observed in 20% of the subjects. The pathologic process stabilized in 41% of the patients but subjective and objective symptoms progressed in 39%. Stabilization is considered to be primarily due to cessation of contact with vibration, while reversal of the pathologic process is hindered by accompanying diseases such as chronic gastrisis, cholecystitis and hypertension.
[558-6508]

THE MODELING OF SOME FUNCTIONS OF HUMAN VISION

Moscow BIOFIZIKA in Russian Vol 25, No 1, Jan/Feb 80 pp 153-158 manuscript received 22 Feb 79

LEBEDEV, D. G., Institute of Information Transfer Problems, USSR Academy of Sciences, Moscow

[Abstract] The following vision functions were modeled: formation of an empty field with stabilization of grid projection; space integration, i.e., filling of empty fields with retention of high resolution capability; observation of the so-called "comets" during artificial translocation of stabilized grid images and the effect of illumination of the far periphery of the grid on the visible brightness. The following characteristics of the model were noted: the contour signal represents a Laplasian of the initial image; this Laplasian is obtained by the drift of the visual axes of the eyes. The signal from each receptor proceeds along two parallel channels, one of which is a low frequency channel and the other - a high frequency supplemental channel with the filter F. Filling of the empty fields is performed by spacial integration. Figure 1, references 7: all Russian.
[266-7813]

UDC 612:51.001.57

SELF-REGULATORY CHARACTERISTICS OF THE HUMAN CARDIOVASCULAR SYSTEM IN CLINO- AND ORTHOSTASIS (MATHEMATICAL MODELING)

Kiev FIZIOLOGICHESKIY ZHURNAL in Russian No 1, 1980 pp 96-103 manuscript received 29 Jun 78

PALETS, B. L. and GRIGORYAN, R. D., Institute of Cybernetics, Ukrainian Academy of Sciences, Kiev

[Abstract] A mathematical model based on an ALGOL program for a BEhSM-6 high-speed computer is proposed for the human cardiovascular system reacting to a 10-s ortho test with the condition of closed neuroreflex links. This model takes into account the self-regulatory characteristics of the heart and resistance--capacitance properties of vessels. It was used to analyze the sensitivity of minute blood volume (Q) and mean arterial pressure (P_A) to changes in heart rate (F), inotropic state of the heart (k), total peripheral resistance, and relaxed volume (U) and inflexibility (D) of the venous pool during clino- and orthostasis. In both states, Q and P_A were most sensitive to change in U. With a shift to the vertical position, sensitivity of Q and P_A to k and F decreased and their sensitivity to changes in D increased markedly. During orthostasis, blood volume and pressure in central regions of the cardiovascular system decreased and

blood flow was reduced. Brain circulation decreased parallel to Q after 3 s of orthostasis. Total peripheral resistance increased by 8%. These changes are attributed to the pronounced drainage of blood from the upper to the lower regions of the vascular system. According to the model, circulation is regulated by a variable control structure which takes into account cardiac and vascular parameters and affects the function of other body systems. Figures 3; references 17: 9 Russian, 8 Western. [236-9307]

UDC 612.821

THE DYNAMICS OF AUTONOMIC REACTIONS IN VOLUNTARY CONTROL OF ALPHA-RHYTHM

Moscow FIZIOLOGIYA CHELOVEKA in Russian Vol 5, No 5, May 1979 pp 927-930
manuscript received 5 Dec 77

MARKMAN, V. G., Institute of Physiology imeni I. P. Pavlov of the USSR Academy of Sciences, Leningrad

[Abstract] Interaction among parameters of alpha-rhythm intensity during voluntary control, heart rate and galvanic skin response was studied among two groups of five test subjects each. Feedback experiments helped the test subjects to control alpha-rhythm, with a corresponding increase of heart rate. The increase of alpha-rhythm is shown to be an emotional response to the feedback signal. The differences of the test subjects show the differences of the functional organization of hypothalamic and cortical relationships and may be used for preliminary separation of test subjects in occupational selection. Figures 1; references 8: 8 Russian.
[9844/0343]

UDC 62-50:611.8

STRUCTURAL THEORIES OF THE ORGANIZATION OF THE NERVOUS SYSTEM

Moscow AVTOMATIKA I TELEMEKHANIKA in Russian No 11, 1979 pp 152-160
manuscript received 27 Nov 78

GOROZHANIN, V. S., Kustanay

Abstract] A new appraoch to a formal description of the functioning of the brain is proposed. The approach is based on considering such cerebral structures (blocks) as the neocortex, the hypothalamus, the reticular formation, etc., which differ functionally and morphologically, rather than such smaller elements as neurons, gliocytes, and synaptic endings,

or the brain as a whole. This approach logically entails the use of methods of the control theory, since the isolation of discrete structures or units or blocks and their interconnections, can result in analysis of the behavior of the system as a whole as in control theory. It is shown that a large number of such diverse problems of neurophysiology as the origin of individual differences in the properties of the nervous system, the genesis of evoked brain potentials and biological rhythms, and the rise of pathological states can be substantively interpreted in terms of the control theory. Then, moreover, in some cases the language of control theory proves to be more adequate than biological terms proper (in analysis of the EEG rhythm assimilation response and of evoked brain potentials). Figures 2; references 18: 16 Russian, 2 Western.
[159-1386]

UDC 612.822.3+591.51

INTERACTION BETWEEN THE HIPPOCAMPUS AND THE POSTERIOR HYPOTHALAMUS IN ACCOMPLISHING THE ORIENTATION REFLEX

Moscow ZHURNAL VYSSHEY NERVNOY DEYATEL'NOSTI in Russian Vol 29, No 3, May-Jun 1979 pp 605-612 manuscript received 1 Mar 78

BORAVOVA, A. I., Brain Institute of the USSR Academy of Medical Sciences, Moscow

[Abstract] Electrical stimulation was used to study the internal relationships of the hippocampus and posterior hypothalamus in chronic and acute experiments on 13 rabbits 3 to 3.5 months of age. Electrical stimulation of the posterior hypothalamus caused orienting behavior in the form of alertness and orienting motions with sniffing and listening in the test animals. There is a different latent period of orienting behavior depending on the intensity and length of the stimulating current and also on the location of the electrical stimulus. Neurons of the hippocampus with lower and higher level of activity have less ability to modulate the discharges during electrical stimulation of the posterior hypothalamus. Electrical stimulation of the hypothalamus, accompanied by the occurrence of orienting behavior, alters the pulse activity of a considerable number of hippocampic cells. Tonic activation and inhibition responses with long aftereffect are a dominant type of response. The nonspecific nature of responses of the hippocampic cells to electrical stimulation of the posterior hypothalamus indicate functional manifestations of hypothalamic afferentation, which rises in the dorsal hippocampus during orienting behavior. Figures 4, references 20: 12 Russian, 8 Western.
[9844/0363]

UDC 612.833.3-063:612.826.4

EFFECT OF TETANUS TOXIN ON NOREPINEPHRINE RELEASE BY RAT BRAIN SYNAPTOSOMES

Moscow BYULLETEN' EKSPERIMENTAL'NOY BIOLOGII I MEDITSINY in Russian No 2, 1980 pp 148-150 manuscript received 19 Jan 79

KRYZHANOVSKIY, G. N., RODINA, V. I., GLEBOV, R. N. and BAZYAN, A. S., Moscow, Institute of General Pathology and Pathological Physiology, USSR Academy of Medical Sciences

[Abstract] The effect of purified tetanus toxin (TT) on the release of both endogenous and exogenous (^{14}C-tagged) norepinephrine from rat brain synaptosomes was investigated. The synaptosomes used in the experiments were isolated from the cerebral tissue of white rats. It was found that purified TT (80-800 Dlm/mg protein) causes enhanced secretion of both endogenous and exogenous norepinephrine from the synaptosomes and does not inhibit the secretion of norepinephrine due to depolarizing agents. Both these effects are here described for the first time, and both these effects become completely inhibited upon inactivating TT with anti-tetanus serum. Thus while TT is known to inhibit the release of glycine, acetyl choline, and dopamine from presynaptic terminals, it contrariwise stimulates the release of norepinephrine from synaptosomes. The mechanism of this phenomenon remains as yet unclear. Figures 2; references 15: 5 Russian, 10 Western.
[248-1386]

UDC 612.014.461.2

CHARACTERISTICS OF RESPIRATION, BLOOD CIRCULATION AND OXYGEN REGIMES IN HUMANS DURING HYPERBARIC HYPEROXIA

Kiev FIZIOLOGICHESKIY ZHURNAL in Russian No 1, 1980 pp 45-52 manuscript recieved 11 Dec 78

GULYAR, S. A., Division of Hypoxic States, A. A. Bogomolets Institute of Physiology, Ukrainian Academy of Sciences, Kiev

[Abstract] Interrelations of basic respiratory and hemodynamic parameters determining oxygen transport were studied in 32 divers (22-33 years of age) for 2 hrs in a helium-oxygen environment containing 20.9 and 13.3% O_2 at 2.5 and 4 kgf/cm^2 (P_{O_2} = 384 and 204 and 618 and 393 mm Hg, respectively). An experimental setup "Barograf" was designed in which the gas mixture supply to test subjects was controlled remotely and respiration and circulation parameters were monitored directly. During rest hyperbaric hyperoxia did not cause any significant changes in body oxygen demand, minute volume or respiration frequency. Respiratory volume and physiologic

dead space increased. The ratio of alveolar to pulmonary ventilation did not change. Partial CO_2 pressure in alveoli did not change at 2.5 kgf/cm^2, but increased by 7.5% at a P_{O_2} of 618 mm Hg. The basic mechanism for reduction in minute blood volume (14.9-19.2%) during hyperbaric hypoxia was the increase in total peripheral resistance (29.7-32.9%). Bradycardia and reduction in systolic volume had a less important role. The ventilation/perfusion ratio was highest at 4 kgf/cm^2 and exceeded base values by 40.5-42.1%. Respiratory and hemodynamic shifts were caused by an increase in arterial blood oxygen tension resulting from an increase in oxygen diffusion in plasma and the more complete saturation of hemoglobin with oxygen. The rate of oxygen entry into the respiratory tract and alveoli increased by 164.7-361.1% and 170.8-371.3% at 2.5 and 4 kgf/cm^2, respectively, and the rate of its transport in arterial and mixed venous blood decreased. Body oxygen efficiency and effectiveness were reduced at the stage of oxygen entry into lungs and increased at the stage of its transport by blood. The reduction of the oxygen content in inspired air promotes normalization of the body oxygen regime; however, normal oxygen mixtures may be physiologically optimal for this pressure range. Figures 1; references 17: 10 Russian, 7 Western.
[236-9307]

UDC 612.014.461.2

GAS CHROMATOGRAPHIC INVESTIGATION OF BLOOD RESPIRATORY FUNCTION IN HUMANS UNDER HYPERBARIC CONDITIONS

Kiev FIZIOLOGICHESKIY ZHURNAL in Russian No 1, 1980 pp 57-82 manuscript received 28 Feb 78

GULYAR, S. A., KOROL, A. N. and MOISEENKO, Ye. V., Division of Hypoxic States, A. A. Bogomolets Institute of Physiology, Ukrainian Academy of Sciences; L. V. Pisarzhevskiy Institute of Physical Chemistry, Ukrainian Academy of Sciences, Kiev

[Abstract] A gas chromatograph with a catharometer was used in an analytical unit within its barometric chamber. Gases were isolated from blood in an extraction chamber chemically with the use of the Van Slyke reagent and by a gas chromatograph consisting of two columns. Nitrogen and oxygen were separated on a column with 5A molecular sieves and nitrogen with oxygen and CO_2 on a silica-gel column. Quantitation was carried out by absolute calibration based on peak heights with the use of formulas. As the pressure of gas increased, C_aO_2 and P_{O_2} increased, and at 4 kgf/cm^2 C_aO_2 surpassed base level by 17.8%. At 6.5 kgf/cm^2 with the use of the nitrogen-oxygen respiration mixture, C_aO_2 increased only by 7.5%. C_aO_2 remained elevated also after decompression. The increase in C_aO_2 is due to the more complete saturation of hemoglobin with oxygen and also the increase in physical diffusion of oxygen in plasma. Reduction of P_{O_2} of

of the inspired gas mixture reduced C_aO_2. There were no changes in the ratios of blood buffer parameters; this, together with a shift to an acid pH and increase in C_aCo_2 and P_aCO_2, indicates that short-term exposure to hyperbaric conditions provokes respiratory acidosis but does not cause any metabolic shifts. The increase in C_aO_2 but not in C_aCO_2 and pH under normal pressure with an air mixture containing 43.9 and 98% oxygen indicates that the oxygen blockade of hemoglobin is not a basic factor in the increase in blood CO_2 tension at a higher pressure. During inhalation of a hyperoxic mixture, C_aCO_2 decreases slightly because of hyperventilation with minor changes in other acid-base balance parameters and a reduction of C_aN_2. Figures 2; references 24: 7 Russian, 17 Western. [236-9307]

UDC 612.58

HEAT PRODUCTION OF ISOLATED SKELETAL MUSCLES OF ALBINO RATS ACCLIMATED TO COLD

Leningrad FIZIOLOGICHESKIY ZHURNAL SSSR in Russian No 4, 1978 pp 543- 49
manuscript received 23 May 77

SOBOLEV, V. I., Chair of Human and Animal Physiology (Chairman S. A. Pevnyy), Donetsk State University

[Abstract] In experiments on two groups of albino rats, cold-acclimated and controls, using a calorimeter of special construction with selected sensitivity of 0.65 mcal/mm and measurement time constant 20 sec, a study was made of the production of heat within isolated skeletal muscles (m. extensor digitorum longus). Measurements of heat production were carried out under aerobic conditions at 37°. Experiments showed that upon the 3-second isometric tetanus the heat production of muscles in cold-acclimated animals was 56.2±2.8 and in non-acclimated ones 45.6±3.9 mcal/sec/g. A preliminary injection of noradrenaline (0.4 mg/kg) caused a 29.9% increase of heat production of isometrically contracting muscles only in cold-acclimated animals (from 56.2±2.8 to 68.2±3.8 mcal/sec/g). The cooling of this group of animals to rectal temperature of 35° was also accompanied by increase in contractile muscle thermogenesis. Figures 2, tables 3, references 13: 12 Russian, 1 Western.
[241-1015]

UDC 612.745+612.4

HEAT PRODUCTION OF ISOLATED SKELETAL MUSCLES OF ALBINO RATS IN EXPERIMENTAL HYPER- AND HYPOTHYROIDISM

Leningrad FIZIOLOGICHESKIY ZHURNAL SSSR in Russian No 2, 1978 pp 177-183
manuscript received 6 Apr 77

SOBOLEV, V. I., Chair of Human and Animal Physiology (Chairman S. A. Pevnyy) State University, Donetsk

[Abstract] A study of the heat production of isolated skeletal muscles (m. extensor digitorum longus) of albino rats was carried out under conditions of experimental hyper- and hypothyroidism and under the effect of catecholamines, using a microcalorimeter of special construction with parameters: sensitivity 0.41 mcal/mm, measurement time constant 20 sec. Three groups of adult male rats with average weight of 200 g were used. In the first group of animals experimental hyperthyroidism was induced by introducing per os 30 mcg/kg of triiodothyronine for 10 days. In rats of the second group experimental hypothyroidism was brought about by introducing per os 20 mg/kg of antithyroid preparation mercazolyl for 20 days. The third group served as a control. The total heat production was measured in all animals isometrically. In a part of rats of each group the given index was determined also after a preliminary (30 min before experiment) introduction of catecholamines (in vivo, I. V.): adrenaline (0.3 mg/kg) and noradrenaline (0.3 mg/kg). Results of measurements of heat production of isolated muscles of rats at 23-25° showed that experimental hyperthyroidism was accompanied by noticeable increase of heat production (+35.3%). Analysis of dependence between rectal temperature and individual values of heat production of investigated muscles showed a connection between these indices: the higher rectal temperature (that is the higher thyrotoxicosis) the greater muscle thermogenesis. Introduction of adrenaline and noradrenaline caused shifts in muscle heat production only in hyperthyroid animals. Total heat production increased in this case by 6.3 ± 2.87 mcal/sec/g, that is by 26.8%. A close correlation existed between increase of rectal temperature, caused by catecholamines, and muscle thermogenesis. In control and hypothyroid animals this connection was absent. Figures 3, tables 3, references 20: 14 Russian, 6 Western. [240-1015]

UDC 612.842.6-06:613.72

THE RELATIONSHIP BETWEEN INTRAOCULAR PRESSURE AND BLOOD PRESSURE IN THE OCULAR ARTERY AND THE RETINAL CAPILLARIES IN ATHLETES UNDER TRAINING CONDITIONS

Moscow VESTNIK OFTAL'MOLOGII in Russian No 1, 1980 pp 31-33 manuscript received 20 Mar 1979

KORABLEV, A. F.

[Abstract] The study involved 227 athletes ranging from 12 to 50 years of age, with 129 females and 98 males divided into categories of speed, endurance and coordination being required to undertake vigorous exercise, then being subjected to pressure and light sensitivity tests. Statistically significant variations before and after load were observed in the threshhold of light sensitivity and in the general effects of physical load on endurance. The relationship between intraocular pressure and blood pressure was regarded as a criterion for the reaction of the organism in general and the eye in particular in assessing the possible effects of physical exercise for athletes. Endurance and coordination motions were found to be prefereble. Figures 4, 1 table, references 10 in Russian. [285-12131]

UDC 615.917'262-053

AGE FACTORS IN EXPERIMENTAL ALCOHOLISM OF RATS OF BOTH SEXES

Moscow FARMAKOLOGIYA I TOKSIKOLOGIYA in Russian No 2, 1980 pp 166-169

ANDRONOVA, L. M., and BARKOV, N. K., Laboratory of Narcotic Pharmacology, Central Institute of Forensic Psychiatry imeni Prof. V. P. Serbskiy, Moscow

[Abstract] Studies were conducted on the formation of alcoholic habits with respect to age and sex, employing outbred white rats divided into sexually immature (81-86 g) and mature (227-257 g) groups. The results showed that on the basis of ad libitum access to 8% ethanol preference for alcohol forms earlier in the immature rats and alcohol consumption exceed 2-3 fold that seen in the adult animals. In addition, alcohol preference is established earlier in the young female rats than in the males. On aging alcohol consumption decreases; however, adult females with an established preference for alcohol consumed greater quantities than the adult males. The greater susceptibility of the younger animals to alcohol is ascribed to dominance of an 'adrenergic profile' which favors more rapid alcohol metabolism. Tables 1; Figures 1; References 14: 5 Russian, 9 Western.
[301-12172]

THE AVIATION PSYCHOLOGIST AND THE FLIGHT SIMULATOR

Moscow PRAVDA in Russian 30 Nov 79 p 6

[Article by Nonna Oreshina]

[Text] Man and machine--living flesh and passionless metal. Problems in their complex collaboration have always existed: man has persistently sought optimum solutions, adapted the machine to himself and himself to it. This has occurred clearly and difficultly in aviation, in military aviation. Characteriscic of today is a complex but regular connection: psychologist-designer-pilot. Our story is about an aviation psychologist.

The steadily bussing semi-darkness of the training room. On the wall glows a pearl-gray screen. And, as if cutting it, slabs of runway rush along and the white pointer of an axial line is thrust into the horizon.

An experiment is going on.

The simulator cabin of a single-seat airplane without a canopy, in the red glow of the instruments seems strangely bare. And a pilot without a crash helmet and the patches of sensors on his hands and face that whiten in the semi-darkness, and the wires that intertwine weightlessly. Special goggles that register the direction of his glances and the path of eye movement make the pilot resemble a strange inhabitant of another planet--a plastic semicircle hangs over his face and the smoked lenses hardly gleamed. The thin crimped tube and the lightguide in a coil run into a motion-picture camera mounted on the side of the cabin.

The pilot adjusts his headphone, touches the microphone prong attached to the corner of his mouth, "Zero ready, shall we repeat the approach?" The experiment leader listens attentively at a control panel in an adjacent room.

His chin and cheek-bones become firm, motion becomes scanty and precise: even in simulated flight the pilot feels stress, and not just because the

the process of control is complicated. The motions reproduce and associate a variegated gamut of real airborne sensations and on the consciousness of responsibility for the experiment is superposed the ordinary, watchful circumspection in flight.

Now the screen in front of the windshield of the cabin is still and dark--the landing must be made by instruments. And only when the airplane flies through a middle marker locator does the screen light up reassuringly brightly, as if dense clouds had been removed from the cockpit canopy, revealing the ground, permitting the pilot to remove this glance from the pointers of the instruments and determine the situation by a simple human glance.

The pilot and the airplane... How are their inter-relationships formed? What is the pledge of flight safety? Why can a pilot commit an error even when the equipment is in good order and he has sufficient experience? To what degree is it necessary to replace man, entrusting the automatic piloting and navigation to automatic systems? These questions also led me to Vladimir Aleksandrovich Ponomarenko, doctor of medical sciences, one of the leading specialists in the area of aviation engineering psychology, a science in which the directions of research are only being determined.

Carefully, trying not to distract the pilot, we go from the training room to the adjacent room where the screen of a TV set is lighted and young associates of the research group--engineers, physiologists, psychologists, etc, sit at the control panel and registering apparatus.

"The instructions must include knowledge of man, of his psychic and physical possibilities," says Vladimir Aleksandrovich. "Flight can be made safe only by creating maximum psychological comfort, so that the pilot in his workplace does not simply hear easily, but thinks easily..."

In aviation it is more complicated to introduce novelty than anywhere else, although it is precisely here that sharp technical thoughts are concentrated precisely and many scientific discoveries of the age cause repercussions in each successive aircraft design. But the changes involve not simply improvement of the aircraft. Thus, aboard contemporary aircraft, to reduce the take-off and landing minima, piloting on complex trajectories and other purposes, automated control systems have been introduced that give a gain in precision and an evident alleviation of the work.

But automation has as it were removed man from the machine. The close connection of man with the aircraft has been destroyed. But in any, even the most "standard" flight, a fine, still not analyzable, "feeling of the aircraft" is required--a state in which the man feels the machine in flight as his own body, when the controls seem to be an extension of his hands and the rhythm of the working engine becomes the beat of his heart, when the idea of spatial position, the determination of his place in the air is inseparable from consciousness.

How is the boundary, beyond which automation changes from an ally to an out-of-place guardian, to be found?

"Technology must support man without interfering with his strong aspects, however. The aircraft is only a tool of labor by means of which the pilot solves tasks presented to him, and in any design it is necessary to create conditions worthy of the personality of the pilot," said V. A. Ponomarenko to me the first time we met. This careful attitude and high respect for the personality of the pilot was born in Vladimir Aleksandrovich as early as the years when he was graduated from the Academy of Military Medicine and entered the position of physician of an aviation unit. And he soon understood that the aviation physician must not only concern himself with practising medicine but also study pilot activity that occurs in conditions of the constant effect of stress factors. He strove to understand peculiarities of psychic processes in flight, to penetrate the stressed work of the mind, the specifics of flight set under conditions of a shortage of time and the creation of constant risk. But to do that it was necessary to know how man in flight perceives the information arriving from the instruments and the environment, how the memory and thinking function. It was necessary to understand which feelings dominate in flights at limitingly low attitudes and in the stratosphere.

To err is human. But in flight error acquires too high a price. Why were a pilot's actions wrong? Where is the reason, in the method of instruction, in the design of the machine or in the possibilities of man? V. A. Ponomarenko and Doctor of Psychological Scients N. D. Zavalov were among the first to demonstrate that error often arises because of inadequate coordination of the technical means with the possibilities of man, and this is not the "personal" but the "human" factor.

To correctly set up a laboratory experiment and model it for flying is an art. But even the most improved simulator cannot give the totalities of feelings that accompany real flight: there are no instrument signals--of sounds, overloads, of circumstances aboard, there is not that high stress that sometimes mobilizes and at other times paralyzes a pilot.

The flight experiment is the most critical critical stage of the tests. One prepares for it carefully and proceeds to it when the possibilities of simulators have been exhausted.

Resounding vibration, the sliding heaviness of accelerations, the massive rumble of engines. The fuselage of a heavy airplane, booming and rattling, encumbered by control and measuring apparatus mounted on scaffolding and shelves, and the cabin, opened wide by windows into the blue, was squeezed by panels of instruments and seems closer than usual--between the pilots' seats sits an operator, and the light-guide hoses creep toward the motion-picture apparatus. Ponomarenko, as the head experimenter, stands with the cabinet of a portable communications panel in his hands behind the armchair of the aircraft commander, trying to see the indications of the instruments

and the faces of the pilots on the right and left simultaneously. His voice resounds persistently: "What have you? Are all the engines working? And the second"..."

In the answers of Commander Vladimir Aleksandrovich sounds something watchful, as he looks at the red light signalling a failure. Why doesn't the experienced pilot notice it?

"The rpm's of the second are dropping and the oil pressure has fallen," he reports. There is stress in the tone of his voice. Registered on the encephalogram are acceleration of the pulse and respiration, movements of the wrist and fingers of the hands... After 2 long seconds: "The second has failed."

"What prevented you from recognizing the signal rapidly?"

The pilot was embarrassed:

"According to the control I felt it pull to the left, but I didn't expect you to disconnnect it without warning... It was my fault, I didn't watch the indicators."

But if not just one, but most of the pilots in such an experiment do not perceive signals with the necessary rapidity, it means it is ineffective and although placed in the field of vision it is not in the field of attention and it is necessary to change its place, to make it a blinker, to bring it out on a display.

To sum up, if we analyze the observations, magnetic tape recordings, the data of oscillographic tapes, and instructive motion-picture frames, it can be understood how actions are predicted under conditions of a shortage of time, where error is hidden in the logic of momentary discussions, which methodical recommendations or design solutions can help.

...I looked in the concentrated face of Vladimir Aleksandrovich, and unwillingly in my memory surfaced his tales about pilots with whom he has risen in the air many times in fighters and heavy aircraft, with whom he has conducted experiments fraught with risk and whom in scientific works, in accordance with the generally accepted practice, he had to call them "pilot K," "pilot M."..

Thanks to the security provided by those whose workplace is the boundless Pacirid Ocean, an engineering psychologist with an alloy of profound medical and aviation knowledge, hardly that of a designer, seeks and finds ways to introduce into the metal very fine human qualities. But, in penetrating the secrets of flight mastery, the investigator has to as it were be introduced into the spirit of the pilot. And bloodless progress is not always painless... How careful the pilot must be of the hands, how balanced and stable the convictions, what tact the scientist must have who takes upon himself the right of responsibility for flights which others make.
[180-2174]

UDC 613.68:612.766.1:612.821-057:359.1

NERVOUS TENSION AND STRESS IN RELATION TO PERFORMANCE OF DUTIES BY SEAMEN

Moscow VOYENNO-MEDITSINSKIY ZHURNAL in Russian No 1, 1980 pp 51-54

SOLODKOV, A. S. and LOBZIN, V. S.

[Abstract] The complex gear carried on modern ships has increased the load on the functions of the central nervous system, the analyzers, and the organism as a whole, thus also enhancing nervous tension and stress (NTaS). Three types of NTaS are isolated: Emotional stress, which can be either negative or positive; hyperstimulation of higher nervous activity or an information overload; and physiological NTaS due to the hypokinesia, partial sensory isolation and perceptual deprivation associated with prolonged ship cruises, particularly submarine cruise. Resistance to NTaS can be increased through proper functional training. Other ways of maintaining a high level of performance of duties in seamen include the assurance of functional and psychological compatibility of a ship's crew. Functional compatibility presupposes a uniform level of training and similar parameters of mental and physiological functions and processes. Psychological compatibility refers to harmonious interpersonal relationships within an entire team performing a given task. It has been observed during prolonged cruises that individuals develop a more acute desire for privacy and the number of interpersonal conflicts increases. This points to the need to allow for psychosocial affinities when selecting a ship's crew. NTaS is generally accompanied by various vegetative disorders. In daily practice, neurotic reactions and the attendant shifts in functions of the organism should be distinguished from physiological changes due to unfavorable environmental (weather) factors, so as to facilitate the adoption of appropriate preventive measures. References 13: 12 Russian, 1 Western.
[250-1386]

UDC 615.471:616-073.65-71

ANALOG MODEL OF INTERACTION OF THE HUMAN BODY-TEMPERATURE SENSOR-ENVIRONMENT SYSTEM

Moscow MEDITSINSKAYA TEKHNIKA in Russian No 4, Apr 1979 pp 17-21 manuscript received 14 Sep 78

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[Abstract] A simply analog model is described for measuring the interaction of the human body with a temperature sensor and the environment. The temperature measurements were divided into three main types: surface body temperature, intracavity temperature measurement and temperature

measurement in semiclosed regions. The given model provides good description of the real interaction between the temperature sensor and the human body. The analytical expressions which describe the model permit one to determine the real dynamic parameters of the temperature sensor and human body system by several samples of the transition characteristic.
Figures 3; references 2: 2 Russian.
[9844/0345]

QUANTITATIVE ESTIMATION OF THE LABOR OF THE OPERATOR

Moscow MORSKOY SBORNIK in Russian No 1, 1980 pp 42-45

OKSENGENDLER, G.

[Abstract] The complexity of the labor of the human operator is a major factor in the capability of a "man-machine" system. Estimation of that complexity yields the data needed to streamline the labor and training of the operators. Since the operator's labor is chiefly mental, its complexity depends mainly on the magnitude and nature of the load on the various analyzer systems of the human organism (visual, auditory, motor, etc.). It is shown in this connection that a time-and-motion study of the various functions performed by the operators in handling specific elements of the control system such as measuring instruments, mnemonic circuits, levers, handles, switches, etc. serves to compute the frequencies (probabilities) of each of these operations. A corresponding formula is presented. The index H of discrete most important operations, serving to compare their degree of complexity, is discussed. It is shown that the degree to which an operation is stereotyped is another criterion of its complexity. The more stereotypical an operation is, the less complex it is. Such qualitative factors as emotional tension can be minimized if the operator is trained in all the possible variants of his operations. On the whole, the use of statistical indexes serves to quantitatively estimate the complexity of control functions and to solve practical problems of enhancing the reliability of performance of various shipboard specialists.
[225-1386]

UDC 340.63+362.2:34

CERTAIN LEGAL QUESTIONS RELATED TO COURT-PSYCHIATRIST TESTIMONY AND FORCED TREATMENT OF THE MENTALLY ILL WHO HAVE COMMITTED SOCIALLY DANGEROUS ACTS

Moscow SUDEBNO-MEDITSINSKAYA EKSPERTIZA in Russian No 1, 1980 pp 47-48
manuscript received 28 Mar 79

ULITSKIY, S. Ya., The Department of Criminal Law and Trials of the Far Eastern State University, Vladivostok

[Abstract] The two positions that (1) an expert should or (2) should not make a determination on the responsibility of a mentally ill patient are considered. The author suggests that an expert be the one to make the determination since, as far as investigative bodies and courts are concerned, the important thing is not the label attached to a mental disorder but the determination as to whether a person in a given situation is capable of understanding and controlling his actions. Soviet precedents and legal guarantees of the rights of the mentally ill are mentioned in relation to this problem. References 13 in Russian.
[279-12131]

CSO: 1840

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